Electrical network protection

Sepam series 20

User's manual
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a brand of Schneider Electric

Merlin Gerin

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Sepam series 20

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Presentation

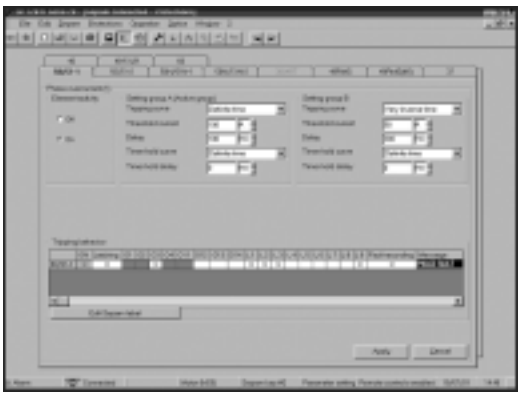
PE50297

Sepam a modular solution.

PE50298

Sepam with basic UMI and with fixed advanced UMI.

PE50593



Example of an SFT2841 software screen.

The Sepam series 20 family of protection and metering units is designed for the operation of machines and electrical distribution networks of industrial installations and utility substations for all levels of voltage.
The Sepam series 20 family consists of simple, high-performing solutions, suited to demanding applications that call for current and voltage metering.

Sepam series 20 selection guide by application

Selection criteria	**Series 20**		
Measurements	I	U	U
Specific protection functions			Loss of mains (ROCOF)
Applications			
Substation	**S20**		
Transformer	**T20**		
Motor	**M20**		
Busbar		**B21**	**B22**

Main functions

Protection

- Overcurrent and earth fault protection with adjustable time reset and with switching from on setting group to the other controlled by a logic order
- Earth fault protection insensitivity to transformer switching
- Detection of phase unbalance
- RMS thermal protection which takes into account external operating temperature and ventilation operating rates
- Rate of change of frequency protection (ROCOF), for a fast and reliable disconnection.

Communication

Sepam can be connected to a supervision communication network (S-LAN) based on the following communication protocols:

- Modbus RTU
- DNP3
- IEC 60870-5-103.

All the data needed for centralized equipment management from a remote monitoring and control system are available via the communication port:

- reading: all measurements, alarms, protection settings,...
- writing: breaking device remote control orders,...

Note: *2 manuals describe the use of DNP3 and IEC 60870-5-103 protocols for all Sepam units:*
- *DNP3 communication user manual, reference SEPED305001EN*
- *IEC 60870-5-103 communication user manual, reference SEPED305002EN.*

Diagnosis

3 types of diagnosis data for improved operation:

- network and machine diagnosis: tripping current, unbalance ratio, disturbance recording
- switchgear diagnosis: cumulative breaking current, operating time
- diagnosis of the protection unit and additional modules: continuous self-testing, watchdog.

Control and monitoring

Circuit breaker program logic ready to use, requiring no auxiliary relays or additional wiring.

User Machine Interface

2 levels of User Machine Interface (UMI) are available according to the user's needs:

- **basic UMI:**

an economical solution for installations that do not require local operation (run via a remote monitoring and control system)

- **fixed or remote advanced UMI:**

a graphic LCD display and 9-key keypad are used to display the measurement and diagnosis values, alarm and operating messages and provide access to protection and parameter setting values, for installations that are operated locally.

Setting and operating software

The **SFT2841** PC software tool gives access to all the Sepam functions, with all the facilities and convenience provided by a Windows type environment.

Selection table

		Substation	Transformer	Motor	Busbar	
Protection	**ANSI code**	**S20**	**T20**	**M20**	**B21 (3)**	**B22**
Phase overcurrent	50/51	4	4	4		
Earth fault / Sensitive earth fault	50N/51N 50G/51G	4	4	4		
Negative sequence / unbalance	46	1	1	1		
Thermal overload	49RMS		2	2		
Phase undercurrent	37			1		
Excessive starting time, locked rotor	48/51LR/14			1		
Starts per hour	66			1		
Positive sequence undervoltage	27D/47				2	2
Remanent undervoltage	27R				1	1
Phase-to-phase undervoltage	27				2	2
Phase-to-neutral undervoltage	27S				1	1
Phase-to-phase overvoltage	59				2	2
Neutral voltage displacement	59N				2	2
Overfrequency	81H				1	1
Underfrequency	81L				2	2
Rate of change of frequency	81R					1
Recloser (4 cycles)	79	□				
Thermostat / Buchholz	26/63		□			
Temperature monitoring (8 RTDs)	38/49T		□	□		
Metering						
Phase current I1, I2, I3 RMS, residual current I0		■	■	■		
Demand current I1, I2, I3, peak demand current IM1, IM2, IM3		■	■	■		
Voltage U21, U32, U13, V1, V2, V3, residual voltage V0					■	■
Positive sequence voltage Vd / rotation direction					■	■
Frequency					■	■
Temperature			□	□		
Network and machine diagnosis						
Tripping current TripI1, TripI2, TripI3, TripI0		■	■	■		
Unbalance ratio / negative sequence current Ii		■	■	■		
Disturbance recording		■	■	■	■	■
Thermal capacity used			■	■		
Remaining operating time before overload tripping			■	■		
Waiting time after overload tripping			■	■		
Running hours counter / operating time			■	■		
Starting current and time				■		
Start inhibit time Number of starts before inhibition				■		
Switchgear diagnosis						
Cumulative breaking current		■	■	■		
Trip circuit supervision		□	□	□	□	□
Number of operations, operating time, charging time		□	□	□		
Control and monitoring	**ANSI code**					
Circuit breaker / contactor control (1)	94/69	□	□	□	□	□
Latching / acknowledgement	86	■	■	■	■	■
Logic discrimination	68	□	□	□		
Switching of groups of settings		■ (2)	■ (2)	■ (2)		
Annunciation	30	■	■	■	■	■
Additional modules						
8 temperature sensor inputs - MET148-2 module			□	□		
1 low level analog output - MSA141 module		□	□	□	□	□
Logic inputs/outputs - MES114/MES114E/MES114F (10I/4O) module		□	□	□	□	□
Communication interface - ACE949-2, ACE959, ACE937, ACE969TP or ACE969FO		□	□	□	□	□

■ standard, □ according to parameter setting and MES114/MES114E/MES114F or MET148-2 input/output module options.

(1) *For shunt trip unit or undervoltage trip unit.*

(2) *Exclusive choice between logic discrimination and switching from one 2-relay group of settings to another 2-relay group.*

(3) *Performs Sepam B20 functions.*

Technical characteristics

Weight

Minimum weight (base unit with basic UMI and without MES114)	1.2 kg
Maximum weight (base unit with advanced UMI and MES114)	1.7 kg

Analog inputs

Current transformer	Input impedance	< 0.02 Ω
1 A or 5 A CT (with CCA630)	Consumption	< 0.02 VA at 1 A
1 A to 6250 A ratings		< 0.5 VA at 5 A
	Rated thermal withstand	4 In
	1-second overload	100 In
Voltage transformer	Input impedance	> 100 kΩ
220 V to 250 kV ratings	Input voltage	100 to 230/√3 V
	Rated thermal withstand	240 V
	1-second overload	480 V

Temperature sensor input (MET148-2 module)

Type of sensor	Pt 100	Ni 100 / 120
Isolation from earth	None	None
Current injected in sensor	4 mA	4 mA
Maximum distance between sensor and module	1 km	

Logic inputs

		MES114	MES114E		MES114F	
Voltage		24 to 250 V DC	110 to 125 V DC	110 V AC	220 to 250 V DC	220 to 240 V AC
Range		19.2 to 275 V DC	88 to 150 V DC	88 to 132 V AC	176 to 275 V DC	176 to 264 V AC
Frequency		-	-	47 to 63 Hz	-	47 to 63 Hz
Typical consumption		3 mA	3 mA	3 mA	3 mA	3 mA
Typical switching threshold		14 V DC	82 V DC	58 V AC	154 V DC	120 V AC
Input limit voltage	At state 1	⩾ 19 V DC	⩾ 88 V DC	⩾ 88 V AC	⩾ 176 V DC	⩾ 176 V AC
	At state 0	⩽ 6 V DC	⩽ 75 V DC	⩽ 22 V AC	⩽ 137 V DC	⩽ 48 V AC

Relays outputs

Control relay outputs (O1, O2, O11 contacts) (2)

Voltage	DC	24 / 48 V DC	127 V DC	220 V DC	
	AC (47.5 to 63 Hz)	-	-	-	100 to 240 V AC
Continuous current		8 A	8 A	8 A	8 A
Breaking capacity	Resistive load	8 / 4 A	0.7 A	0.3 A	
	L/R load < 20 ms	6 / 2 A	0.5 A	0.2 A	
	L/R load < 40 ms	4 / 1 A	0.2 A	0.1 A	
	Resistive load	-	-	-	8 A
	p.f. load > 0.3	-	-	-	5 A
Making capacity	< 15 A for 200 ms				

Annunciation relay output (O3, O4, O12, O13, O14 contacts)

Voltage	DC	24 / 48 V DC	127 V DC	220 V DC	
	AC (47.5 to 63 Hz)	-	-	-	100 to 240 V AC
Continuous current		2 A	2 A	2 A	2 A
Breaking capacity	L/R load < 20 ms	2 / 1 A	0.5 A	0.15 A	
	p.f. load > 0.3	-	-	-	1 A

Power supply

Voltage	24 / 250 V DC	110 / 240 V AC
Range	-20 % +10 %	-20 % +10 % (47.5 to 63 Hz)
Deactivated consumption (1)	< 4.5 W	< 9 VA
Maximum consumption (1)	< 8 W	< 15 VA
Inrush current	< 10 A for 10 ms, < 28 A for 100 ms	< 28 A for 100 ms, < 15 A for first half-period
Acceptable momentary outages	10 ms	20 ms

Analog output (MSA141 module)

Current	4 - 20 mA, 0 - 20 mA, 0 - 10 mA
Load impedance	< 600 Ω (wiring included)
Accuracy	0.50 %

(1) *According to configuration.*
(2) *Relay outputs comply with clause 6.7 of standard C37.90 (30 A, 200 ms, 2000 operations).*

Environmental characteristics

Electromagnetic compatibility	Standard	Level / Class	Value
Emission tests			
Disturbing field emission	IEC 60255-25		
	EN 55022	A	
Conducted disturbance emission	IEC 60255-25		
	EN 55022	B	
Immunity tests – Radiated disturbances			
Immunity to radiated fields	IEC 60255-22-3		10 V/m ; 80 MHz - 1 GHz
	IEC 61000-4-3 (1)	III	10 V/m ; 80 MHz - 2 GHz
	ANSI C37.90.2 (1)		35 V/m ; 25 MHz - 1 GHz
Electrostatic discharge	IEC 60255-22-2		8 kV air ; 6 kV contact
	ANSI C37.90.3 (1)		8 kV air ; 4 kV contact
Immunity to magnetic fields at network frequency	IEC 61000-4-8	IV	30 A/m (continuous) - 300 A/m (13 s)
Immunity tests – Conducted disturbances			
Immunity to conducted RF disturbances	IEC 60255-22-6		10 V
Fast transient bursts	IEC 60255-22-4	A or B	4 kV ; 2.5 kHz / 2 kV ; 5 kHz
	IEC 61000-4-4	IV	4 kV ; 2.5 kHz
	ANSI C37.90.1 (1)		4 kV ; 2.5 kHz
1 MHz damped oscillating wave	IEC 60255-22-1	III	2.5 kV MC ; 1 kV MD
	ANSI C37.90.1 (1)		2.5 kV MC and MD
100 kHz damped oscillating wave	IEC 61000-4-12		2.5 kV MC ; 1 kV MD
Surges	IEC 61000-4-5	III	2 kV MC ; 1 kV MD
Voltage interruptions	IEC 60255-11		Series 20: 100 %, 10 ms Series 40: 100 %, 20 ms

Mechanical robustness	Standard	Level / Class	Value
In operation			
Vibrations	IEC 60255-21-1	2	1 Gn ; 10 Hz - 150 Hz
	IEC 60068-2-6	Fc	2 Hz - 13.2 Hz ; a = ±1 mm
Shocks	IEC 60255-21-2	2	10 Gn / 11 ms
Earthquakes	IEC 60255-21-3	2	2 Gn (horizontal axes) 1 Gn (vertical axes)
De-energized			
Vibrations	IEC 60255-21-1	2	2 Gn ; 10 Hz - 150 Hz
Shocks	IEC 60255-21-2	2	27 Gn / 11 ms
Jolts	IEC 60255-21-2	2	20 Gn / 16 ms

Climatic withstand	Standard	Level / Class	Value
In operation			
Exposure to cold	IEC 60068-2-1	Series 20: Ab Series 40: Ad	-25 °C
Exposure to dry heat	IEC 60068-2-2	Series 20: Bb Series 40: Bd	+70 °C
Continuous exposure to damp heat	IEC 60068-2-3	Ca	10 days ; 93 % RH ; 40 °C
Temperature variation with specified variation rate	IEC 60068-2-14	Nb	–25 °C to +70 °C 5°C/min
Salt mist	IEC 60068-2-52	Kb/2	
Influence of corrosion	IEC 60068-2-60	C	21 days ; 75 % RH ; 25 °C ; 0.5 ppm H_2S ; 1 ppm SO_2
Gaz test 4	IEC 60068-2-60		21 days ; 75 % RH ; 25 °C ; 0.01 ppm H_2S ; 0.2 ppm SO_2 ; 0.02 ppm NO_2 ; 0.01 ppm Cl_2
In storage (4)			
Exposure to cold	IEC 60068-2-1	Ab	-25 °C
Exposure to dry heat	IEC 60068-2-2	Bb	+70 °C
Continuous exposure to damp heat	IEC 60068-2-3	Ca	56 days ; 93 % RH ; 40 °C

Safety	Standard	Level / Class	Value
Enclosure safety tests			
Front panel tightness	IEC 60529	IP52	Other panels closed, except for rear panel IP20
	NEMA	Type 12 with gasket supplied	
Fire withstand	IEC 60695-2-11		650 °C with glow wire
Electrical safety tests			
1.2/50 µs impulse wave	IEC 60255-5		5 kV (2)
Power frequency dielectric withstand	IEC 60255-5		2 kV 1 mn (3)

Certification

CE	Harmonized standard: EN 50263	European directives: ■ 89/336/CEE Electromagnetic Comptability (EMC) Directive □ 92/31/CEE Amendment □ 93/68/CEE Amendment ■ 73/23/CEE Low Voltage Directive □ 93/68/CEE Amendment
UL -	UL508 - CSA C22.2 n° 14-95	File E212533
CSA	CSA C22.2 n° 14-95 / n° 94-M91 / n° 0.17-00	File 210625

(1) *Sepam series 40.*
(2) *Except for communication: 3 kV in common mode and 1kV in differential mode*
(3) *Except for communication: 1 kVrms*
(4) *Sepam must be stored in its original packing.*

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General settings

The general settings define the characteristics of the measurement sensors connected to Sepam and determine the performance of the metering and protection functions used. They are accessed via the SFT2841 setting software General Characteristics tab.

General settings		Selection	Setting range
In	Rated phase current (sensor primary current)	2 or 3 CT 1 A / 5 A	1 A to 6250 A
		3 LPCTs	25 A to 3150 A (1)
Ib	Base current, according to rated power of equipment		0.4 to 1.3 In
In0	Rated residual current	Sum of 3 phase currents	See In rated phase current
		CSH120 or CSH200 core balance CT	2 A or 20 A rating
		1 A/5 A CT + CSH30 interposing ring CT	1 A to 6250 A
		Core balance CT + ACE990 (the core balance CT ratio 1/n must be such that 50 ⩽ n ⩽ 1500)	According to current monitored and use of ACE990
Unp	Rated primary phase-to-phase voltage (Vnp: rated primary phase-to-neutral voltage Vnp = Unp/$\sqrt{3}$)		220 V to 250 kV
Uns	Rated secondary phase-to-phase voltage	3 VTs: V1, V2, V3	100, 110, 115, 120, 200, 230 V
		2 VTs: U21, U32	100, 110, 115, 120 V
		1 VT: V1	100, 110, 115, 120 V
Uns0	Secondary zero sequence voltage for primary zero sequence voltage Unp/$\sqrt{3}$		Uns/3 or Uns/$\sqrt{3}$
	Rated frequency		50 Hz or 60 Hz
	Integration period (for demand current and peak demand current and power)		5, 10, 15, 30, 60 mn

(1) *In values for LPCT, in Amps: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.*

Characteristics

Functions		Measurement range	Accuracy (1)	MSA141	Saving
Metering					
Phase current		0.1 to 40 In (2)	±1 %	■	
Residual current	Calculated	0.1 to 40 In	±1 %	■	
	Measured	0.1 to 20 In0	±1 %	■	
Demand current		0.1 to 40 In	±1 %		
Peak demand current		0.1 to 40 In	±1 %		□
Phase-to-phase voltage		0.05 to 1.2 Unp	±1 %	■	
Phase-to-neutral voltage		0.05 to 1.2 Vnp	±1 %	■	
Residual voltage		0.015 to 3 Vnp	±1 %		
Positive sequence voltage		0.05 to 1.2 Vnp	±5 %		
Frequency Sepam series 20		50 ±5 Hz or 60 ±5 Hz	±0.05 Hz	■	
Temperature		-30 to +200 °C or -22 to +392 °F	±1 °C from +20 to +140 °C	■	
Network diagnosis assistance					
Phase tripping current		0.1 to 40 In	±5 %		□
Earth fault tripping current		0.1 to 20 In0	±5 %		□
Negative sequence / unbalance		10 to 500 % of Ib	±2 %		
Disturbance recording					□
Machine operating assistance					
Thermal capacity used		0 to 800 % (100 % for I phase = Ib)	±1 %	■	□
Remaining operating time before overload tripping		0 to 999 mn	±1 mn		
Waiting time after overload tripping		0 to 999 mn	±1 mn		
Running hours counter / operating time		0 to 65535 hours	±1 % or ±0.5 h		□
Starting current		1.2 Ib to 24 In	±5 %		□
Starting time		0 to 300 s	±300 ms		□
Number of starts before inhibition		0 to 60	1		
Start inhibit time		0 to 360 mn	±1 mn		
Switchgear diagnosis assistance					
Cumulative breaking current		0 to 65535 kA²	±10 %		□
Number of operations		0 to 4.10^9	1		□
Operating time		20 to 100 ms	±1 ms		□
Charging time		1 to 20 s	±0.5 s		□

■ *available on MSA141 analog output module, according to setup.*
□ *saved in the event of auxiliary supply outage.*
(1) *Typical accuracy, see details on subsequent pages.*
(2) *Measurement up to 0.02 In for information purpose.*

Phase current
Residual current

Phase current

Operation

This function gives the RMS value of the phase currents:
- I1: phase 1 current
- I2: phase 2 current
- I3: phase 3 current.

It is based on RMS current measurement and takes into account harmonics up to number 17.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range	0.1 to 1.5 In (1)
Unit	A or kA
Accuracy	typically ±1 % (2) ±2 % from 0.3 to 1.5 In ±5 % if < 0.3 In
Display format (3)	3 significant digits
Resolution	0.1 A or 1 digit
Refresh interval	1 second (typical)

(1) *In rated current set in the general settings.*
(2) *At In, in reference conditions (IEC 60255-6).*
(3) *Display of values: 0.02 to 40 In.*

Residual current

Operation

This operation gives the RMS value of the residual current I0.
It is based on measurement of the fundamental component.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range		
Connection to 3 phase CT:		0.1 to 1.5 In0 (1)
Connection to 1 CT with CSH30 interposing ring CT		0.1 to 1.5 In0 (1)
Connection to core balance CT with ACE990		0.1 to 1.5 In0 (1)
Connection to CSH residual current sensor	2 A rating	0.2 to 3 A
	20 A rating	2 to 30 A
Unit		A or kA
Accuracy (2)		typically ±1 % at In0 ±2 % from 0.3 to 1.5 In0 ±5 % if < 0.3 In0
Display format		3 significant digits
Resolution		0.1 A or 1 digit

(1) *In0 rated current set in the general settings.*
(2) *in reference conditions (IEC 60255-6), excluding sensor accuracy.*

Average current and peak demand currents

Operation

This function gives:

- the average RMS current for each phase that has been obtained for each integration interval
- the greatest average RMS current value for each phase that has been obtained since the last reset.

The values are refreshed after each "integration interval", an interval that may be set from 5 to 60 mn.

Readout

The measurements may be accessed via:

- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Resetting to zero:

- press the clear key on the display when a peak demand current is displayed
- via the clear command in the SFT2841 software
- via the communication link (remote control order TC6).

Characteristics

Measurement range	0.1 to 1.5 In (1)
Unit	A or kA
Accuracy	typically ±1 % (2) ±2 % from 0.3 to 1.5 In ±5 % if < 0.3 In
Display format (3)	3 significant digits
Resolution	0.1 A or 1 digit
Integration interval	5, 10, 15, 30, 60 minutes

(1) *In rated current set in the general settings.*
(2) *at In, in reference conditions (IEC 60255-6).*
(3) *Display of values: 0.02 to 40 In.*

Phase-to-phase voltage
Phase-to-neutral voltage

Phase-to-phase voltage

Operation

This function gives the RMS value of the 50 or 60 Hz component of phase-to-phase voltages (according to voltage sensor connections):

- U21: voltage between phases 2 and 1
- U32: voltage between phases 3 and 2
- U13: voltage between phases 1 and 3.

It is based on measurement of the fundamental component.

Readout

The measurements may be accessed via:

- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range	0.05 to 1.2 Unp (1)
Unit	V or kV
Accuracy (2)	±1 % from 0.5 to 1.2 Unp ±2 % from 0,05 to 0.5 Unp
Display format	3 significant digits
Resolution	1 V or 1 digit
Refresh interval	1 second (typical)

(1) *Un nominal rating set in the general settings.*
(2) *at Un, in reference conditions (IEC 60255-6).*

Phase-to-neutral voltage

Operation

This function gives the RMS value of the 50 or 60 Hz component of phase-to-neutral voltages:

- V1: phase 1 phase-to-neutral voltage
- V2: phase 2 phase-to-neutral voltage
- V3: phase 3 phase-to-neutral voltage.

It is based on measurement of the fundamental component.

Readout

The measurements may be accessed via:

- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range	0.05 to 1.2 Vnp (1)
Unit	V or kV
Accuracy (2)	±1 % from 0.5 to 1.2 Vnp ±2 % from 0.05 to 0.5 Vnp
Display format	3 significant digits
Resolution	1 V or 1 digit
Refresh interval	1 second (typical)

(1) *Vnp: primary rated phase-to-neutral voltage ($Vnp = Unp/\sqrt{3}$).*
(2) *at Vnp in reference conditions (IEC 60255-6).*

Residual voltage
Positive sequence voltage

Residual voltage

Operation

This function gives the value of the residual voltage V0 = (V1 + V2 + V3).
V0 is measured:
- by taking the internal sum of the 3 phase voltages
- by an open star / delta VT.

It is based on measurement of the fundamental component.

Readout

The measurement may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	0.015 Vnp to 3 Vnp (1)
Unit	V or kV
Accuracy	±1 % from 0.5 to 3 Vnp ±2 % from 0.05 to 0.5 Vnp ±5 % from 0.015 to 0.05 Vnp
Display format	3 significant digits
Resolution	1 V or 1 digit
Refresh interval	1 second (typical)

(1) *Vnp: primary rated phase-to-neutral voltage (Vnp = Unp/√3).*

Positive sequence voltage

Operation

This function gives the calculated value of the positive sequence voltage Vd.

Readout

The measurement may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	0.05 to 1.2 Vnp (1)
Unit	V or kV
Accuracy	±2 % at Vnp
Display format	3 significant digits
Resolution	1 V or 1 digit
Refresh interval	1 second (typical)

(1) *Vnp: primary rated phase-to-neutral voltage (Vnp = Unp/√3).*

Frequency Temperature

Frequency

Operation

This function gives the frequency value.
Frequency is measured via the following:
- based on U21, if only one phase-to-phase voltage is connected to the Sepam
- based on positive sequence voltage, if the Sepam includes U21 and U32 measurements.

Frequency is not measured if:
- the voltage U21 or positive sequence voltage Vd is less than 40 % of Un
- the frequency is outside the measurement range.

Readout

The measurement may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

Characteristics

Rated frequency		50 Hz, 60 Hz
Range	50 Hz	45 Hz to 55 Hz
	60 Hz	55 Hz to 65 Hz
Accuracy (1)		±0.05 Hz
Display format		3 significant digits
Resolution		0.01 Hz or 1 digit
Refresh interval		1 second (typical)

***(1)** At Un in reference conditions (IEC 60255-6).*

Temperature

Operation

This function gives the temperature value measured by resistance temperature detectors (RTDs):
- platinum Pt100 (100 Ω at 0 °C) in accordance with the IEC 60751 and DIN 43760 standards
- nickel 100 Ω or 120 Ω (at 0 °C).

Each RTD channel gives one measurement:
- tx = RTD x temperature.

The function also indicates RTD faults:
- RTD disconnected (tx > 205 °C)
- RTD shorted (tx < -35 °C).

In the event of a fault, display of the value is inhibited.
The associated monitoring function generates a maintenance alarm.

Readout

The measurement may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

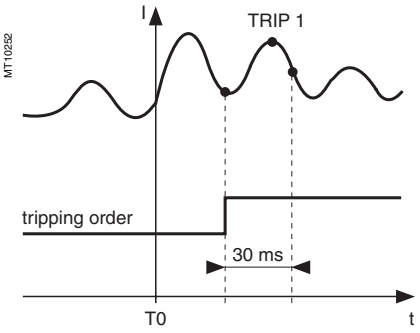
Characteristics

Range	-30 °C to +200 °C or -22 °F to +392 °F
Accuracy (1)	±2 °C ±1 °C from +20 to +140 °C
Resolution	1 °C or 1 °F
Refresh interval	5 seconds (typical)

***(1)** At Un in reference conditions (IEC 60255-6).*

Accuracy derating according to wiring: see chapter "installation of MET148-2 module" page 6/22.

Tripping current
Negative sequence / unbalance



Tripping current

Operation

This function gives the RMS value of currents at the prospective time of the last trip:
- TRIP1: phase 1 current
- TRIP2: phase 2 current
- TRIP3: phase 3 current
- TRIPI0: residual current.

It is based on measurement of the fundamental component.
This measurement is defined as the maximum RMS value measured during a 30 ms interval after the activation of the tripping contact on output O1.
The tripping currents are saved in the event of a power failure.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	phase current 0.1 to 40 In (1)
Residual current	0.1 to 20 In0 (1)
Unit	A or kA
Accuracy	±5 % ±1 digit
Display format	3 significant digits
Resolution	0.1 A or 1 digit

(1) *In/In0 rated current set in the general settings.*

Negative sequence / unbalance

Operation

This function gives the negative sequence component: T = Ii/Ib
The negative sequence current is determined based on the phase currents:
- 3 phases

$$\vec{Ii} = \frac{1}{3} \times (\vec{I1} + a^2\vec{I2} + a\vec{I3})$$

with $a = e^{j\frac{2\pi}{3}}$

- 2 phases

$$\left|\vec{Ii}\right| = \frac{1}{\sqrt{3}} \times \left|\vec{I1} - a^2\vec{I3}\right|$$

with $a = e^{j\frac{2\pi}{3}}$

These 2 formulas are equivalent when there is no earth fault.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	10 to 500
Unit	% Ib
Accuracy	±2 %
Display format	3 significant digits
Resolution	1 %
Refresh interval	1 second (typical)

Disturbance recording

Operation

This function is used to record analog signal and logical states.
Record storage is activated according to parameter setting by a triggering event (see Control and monitoring functions - Disturbance recording triggering).
The stored event begins before the triggering event and continues afterwards.
The record comprises the following information:

- values sampled from the different signals
- date
- characteristics of the recorded channels.

The files are recorded in FIFO (First In First Out) type shift storage: the oldest record is erased when a new record is triggered.

Transfer

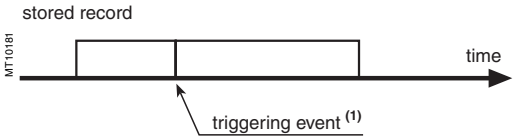
Files may be transferred locally or remotely:

- locally: using a PC which is connected to the pocket terminal connector and has the SFT2841 software tool
- remotely: using a software tool specific to the remote monitoring and control system.

Recovery

The signals are recovered from a record by means of the SFT2826 software tool.

Principle



Characteristics

Record duration	x periods before the triggering event (1) total 86 periods
Record content	Set-up file: date, channel characteristics, measuring transformer ratio Sample file: 12 values per period/recorded signal
Analog signals recorded (2)	4 current channels (I1, I2, I3, I0) or 4 voltage channels (V1, V2, V3)
Logical signals	10 digital inputs, outputs O1, pick-up
Number of stored records	2
File format	COMTRADE 97

(1) *According to parameter setting with the SFT2841 (default setting 36 cycles).*
(2) *According to sensor type and connection.*

Running hours counter and operating time Thermal capacity used

Running hours counter / operating time

The counter gives the running total of time during which the protected device (motor or transformer) has been operating (I > 0.1Ib). The initial counter value may be modified using the SFT2841 software.
The counter is saved every 4 hours.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Range	0 to 65535
Unit	hours

Thermal capacity used

Operation

The thermal capacity used is calculated by the thermal protection function.
The thermal capacity used is related to the load. The thermal capacity used measurement is given as a percentage of the rated thermal capacity.

Saving of thermal capacity used

When the protection unit trips, the current thermal capacity used increased by 10 % **(1)** is saved. The saved value is reset to 0 when the thermal capacity used has decreased sufficiently for the start inhibit time delay to be zero. The saved value is used again after a Sepam power outage, making it possible to start over with the temperature buildup that caused the trip.

(1) *The 10 % increase is used to take into account the average temperature buildup of motors when starting.*

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link
- an analog converter with the MSA141 option.

Characteristics

Measurement range	0 to 800 %
Unit	%
Display format	3 significant digits
Resolution	1 %
Refresh interval	1 second (typical)

Operating time before tripping Waiting time after tripping

Remaining operating time before overload tripping

Operation

The time is calculated by the thermal protection function. It depends on the thermal capacity used.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the Σ key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	0 to 999 mn
Unit	mn
Display format	3 significant digits
Resolution	1 mn
Refresh interval	1 second (typical)

Waiting time after overload tripping

Operation

The time is calculated by the thermal protection function. It depends on the thermal capacity used.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the Σ key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	0 to 999 mn
Unit	mn
Display format	3 significant digits
Resolution	1 mn
Refresh period	1 second (typical)

Starting current and starting / overload time

Operation

The starting / overload time is the time between the moment at which one of the 3 phase currents exceeds 1.2 Ib and the moment at which the 3 currents drop back below 1.2 Ib.
The maximum phase current obtained during this period is the starting / overload current.
The 2 values are saved in the event of an auxiliary power failure.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the Σ key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Starting / overload time	
Measurement range	0 to 300 s
Unit	s or ms
Display format	3 significant digits
Resolution	10 ms or 1 digit
Refresh interval	1 second (typical)
Starting / overload current	
Measurement range	1.2 Ib to 24 In (1)
Unit	A or kA
Display format	3 significant digits
Resolution	0.1 A or 1 digit
Refresh interval	1 second (typical)

(1) *Or 65.5 kA.*

Number of starts before inhibition Start inhibit time delay

Number of starts before inhibition

Operation

The number of starts allowed before inhbition is calculated by the number of starts protection function.
The number of starts depends on the thermal state of the motor.

Readout

The measurements may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Resetting to zero

The number of starts counters may be reset to zero as follows, after the entry of a password:
- on the advanced UMI display unit by pressing the clear key
- on the display of a PC with the SFT2841 software.

Characteristics

Measurement range	0 to 60
Unit	none
Display format	3 significant digits
Resolution	1
Refresh interval	1 second (typical)

Start inhibit time delay

Operation

The time delay is calculated by the number of starts protection function.
If the number of starts protection function indicates that starting is inhibited, the time given represents the waiting time before starting is allowed.

Readout

The number of starts and waiting time may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

Characteristics

Measurement range	0 to 360 mn
Unit	mn
Display format	3 significant digits
Resolution	1 mn
Refresh interval	1 second (typical)

Cumulative breaking current and number of operations

Cumulative breaking current

Operation

This function indicates the cumulative breaking current in square kiloamperes $(kA)^2$ for five current ranges.
It is based on measurement of the fundamental component.
The current ranges displayed are:

- 0 < I < 2 In
- 2 In < I < 5 In
- 5 In < I < 10 In
- 10 In < I < 40 In
- I > 40 In.

The function also provides the total number of operations and the cumulative total of breaking current in $(kA)^2$.
Each value is saved in the event of a power failure.
Refer to switchgear documentation for use of this information.

Number of operation

The function is activated by tripping commands (O1 relay).
This value is saved in the event of a power failure.

Readout

The measurements may be accessed via:

- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

The initial values may be introduced using the SFT2841 software tool to take into account the real state of a used breaking device.

Characteristics

Breaking current $(kA)^2$	
Range	0 to 65535 $(kA)^2$
Unit	primary $(kA)^2$
Accuracy (1)	±10 %
Number of operations	
Range	0 to 65535

(1) *At In, in reference conditions (IEC 60255-6).*

Operating time
Charging time

Operating time

Operation

This function gives the value of the opening operating time of a breaking device (1) and change of status of the device open position contact connected to the I11 input (2).
The function is inhibited when the input is set for AC voltage (3).
The value is saved in the event of a power failure.

Readout

The measurement may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

(1) Refer to switchgear documentation for use of this information.
(2) Optional MES module.
(3) Optional MES114E or MES114F modules.

Characteristics

Measurement range	20 to 100
Unit	ms
Accuracy	typically ±1 ms
Display format	3 significant digits

Charging time

Operation

This function gives the value of the breaking device (1) operating mechanism charging time, determined according to the device closed position status change contact and the end of charging contact connected to the Sepam I12 and I24 (2).
The value is saved in the event of a power failure.

Readout

The measurement may be accessed via:
- the display of a Sepam with advanced UMI by pressing the key
- the display of a PC with the SFT2841 software
- the communication link.

(1) Refer to switchgear documentation for use of this information.
(2) Optional MES114 or MES114E or MES114F modules.

Characteristics

Measurement range	1 to 20
Unit	s
Accuracy	±0.5 sec
Display format	3 significant digits

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General
IDMT protection functions **3/34**

Setting ranges

Functions	Settings		Time delays
ANSI 27 - Phase-to-phase undervoltage			
	5 to 100 % of Unp		0.05 s to 300 s
ANSI 27D/47 - Positive sequence undervoltage			
	15 to 60 % of Unp		0.05 s to 300 s
ANSI 27R - Remanent undervoltage			
	5 to 100 % of Unp		0.05 s to 300 s
ANSI 27S - Phase-to-neutral undervoltage			
	5 to 100 % of Vnp		0.05 s to 300 s
ANSI 37 - Phase undercurrent			
	0.15 to 1 Ib		0.05 s to 300 s
ANSI 38/49T - Temperature monitoring (8 or 16 RTDs)			
Alarm and trip set points	0 to 180 °C (or 32 to 356 °F)		
ANSI 46 - Negative sequence / unbalance			
Definite time	0.1 to 5 Ib		0.1 s to 300 s
IDMT	0.1 to 0.5 Ib		0.1 s to 1 s
ANSI 48/51LR/14 - Excessive starting time, locked rotor			
	0.5 Ib to 5 Ib	ST starting time	0.5 s to 300 s
		LT and LTS time delays	0.05 s to 300 s
ANSI 49RMS - Thermal overload		**Rate 1**	**Rate 2**
Accounting for negative sequence component		0 - 2,25 - 4,5 - 9	
Time constant	Heating	T1: 5 to 120 mn	T1: 5 to 120 mn
	Cooling	T2: 5 to 600 mn	T2: 5 to 600 mn
Alarm and tripping set points		50 to 300 % of rated thermal capacity	
Cold curve modification factor		0 to 100 %	
Switching of thermal settings conditions		By logic input I26 (transformer)	
		By Is set point adjustable from 0.25 to 8 Ib (motor)	
Maximum equipment temperature		60 to 200 °C	
ANSI 50/51 - Phase overcurrent			
	Tripping time delay	**Timer hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	CEI: SIT/A, LTI/B, VIT/B, EIT/C	DT or IDMT	
	IEEE: MI (D), VI (E), EI (F)	DT or IDMT	
	IAC: I, VI, EI	DT or IDMT	
Is set point	0.1 to 24 In	Definite time	Inst ; 0.05 s to 300 s
	0.1 to 2.4 In	IDMT	0.1 s to 12.5 s at 10 Is
Timer hold	Definite time (DT ; timer hold)		Inst ; 0.05 s to 300 s
	IDMT (IDMT ; reset time)		0.5 s to 20 s

(1) *Tripping as of 1.2 Is.*

Setting ranges

Functions	Settings		Time delays
ANSI 50N/51N or 50G/51G - Earth fault / Sensitive earth fault			
	Tripping time delay	**Timer hold**	
Tripping curve	Definite time	DT	
	SIT, LTI, VIT, EIT, UIT (1)	DT	
	RI	DT	
	CEI: SIT/A,LTI/B, VIT/B, EIT/C	DT or IDMT	
	IEEE: MI (D), VI (E), EI (F)	DT or IDMT	
	IAC: I, VI, EI	DT or IDMT	
Is0 set point	0.1 to 15 In0	Definite time	Inst ; 0.05 s to 300 s
	0.1 to 1 In0	IDMT	0.1 s to 12.5 s at 10 Is0
Timer hold	Definite time (DT ; timer hold)		Inst ; 0.05 s to 300 s
	IDMT (IDMT ; reset time)		0.5 s to 20 s
ANSI 59 - Overvoltage phase-to-phase			
	50 to 150 % of Unp		0.05 s to 300 s
ANSI 59N - Neutral voltage displacement			
	2 to 80 % of Unp		0.05 s to 300 s
ANSI 66 - Starts per hour			
Starts per period	1 to 60	Period	1 to 6 hr
Consecutive starts	1 to 60	Time between starts	0 to 90 mn
ANSI 81H - Overfrequency			
	50 to 53 Hz or 60 to 63 Hz		0.1 s to 300 s
ANSI 81L - Underfrequency			
	45 to 50 Hz or 55 to 60 Hz		0.1 s to 300 s
ANSI 81R - Rate of change of frequency			
	0.1 to 10 Hz/s		Inst ; 0.15 s to 300 s

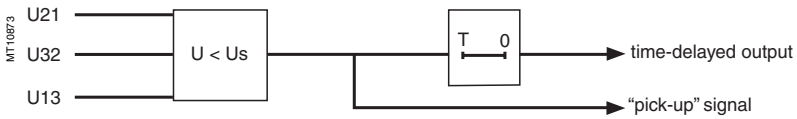
(1) *Tripping as of 1.2 Is.*

Phase-to-phase undervoltage
ANSI code 27

Operation

The protection function is three-phase:
- it picks up if one of the 3 phase-to-phase voltages drops below the Us set point
- it includes a definite time delay T.

Block diagram



Characteristics

Us set point	
Setting	5 % Unp to 100 % Unp
Accuracy (1)	±2 % or 0.005 Unp
Resolution	1 %
Drop-out/pick-up ratio	103 % ±2.5 %
Time delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2 %, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times	
Operation time	pick-up < 35 ms (typically 25 ms)
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*

Positive sequence undervoltage and phase rotation direction check
ANSI code 27D/47

Operation

Positive sequence undervoltage

The protection picks up when the positive sequence component Vd of a three-phase voltage system drops below the Vsd set point with

$$\vec{V}d = \frac{1}{3}(\vec{V}1 + \vec{V}2 + a^2\vec{V}3)$$

$$\vec{V}d = \frac{1}{3}(\vec{U}21 - a^2\vec{U}32)$$

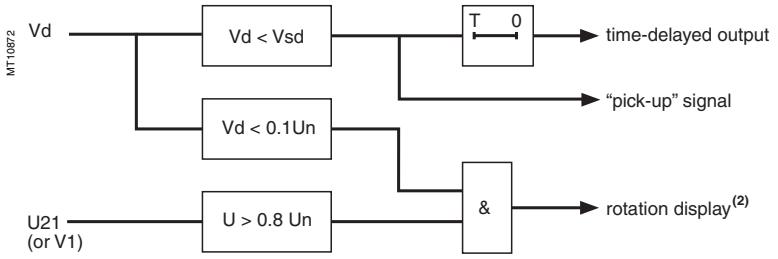
with $V = \frac{U}{\sqrt{3}}$ and $a = e^{j\frac{2\pi}{3}}$

- it includes a definite time delay T
- it allows drops in motor electrical torque to be detected.

Phase rotation direction

This protection also allows the phase rotation direction to be detected.
The protection considers that the phase rotation direction is inverse when the positive sequence voltage is less than 10 % of Unp and when the phase-to-phase voltage is greater than 80 % of Unp.

Block diagram



Characteristics

Vsd set point	
Setting	15 % Unp to 60 % Unp
Accuracy (1)	±2 %
Pick-up/drop-out ratio	103 % ±2.5 %
Resolution	1 %
Time delay	
Setting	50 ms to 300 s
Accuracy (1)	±2 %, or ±25 ms
Resolution	10 ms or 1 digit
Characteristics times	
Operating time	pick-up < 55 ms
Overshoot time	< 35 ms
Reset time	< 35 ms

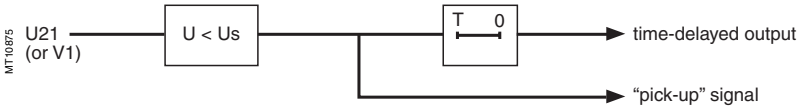
(1) *In reference conditions (IEC 60255-6).*
(2) *Displays "rotation" instead of positive sequence voltage measurement.*

Remanent undervoltage
ANSI code 27R

Operation

This protection is single-phase:
- it picks up when the U21 phase-to-phase voltage is less than the Us set point
- the protection includes a definite time delay.

Block diagram



Characteristics

Us set point	
Setting	5 % Unp to 100 % Unp
Accuracy (1)	±2 % or 0.005 Unp
Resolution	1 %
Drop-out/pick-up ratio	103 % ±2.5 %
Time delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2 %, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times	
Operation time	< 40 ms
Overshoot time	< 20 ms
Reset time	< 30 ms

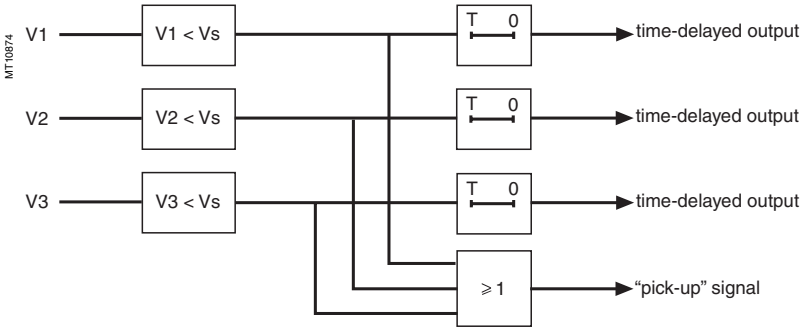
(1) *In reference conditions (IEC 60255-6).*

Phase-to-neutral undervoltage
ANSI code 27S

Operation

This protection is three-phase:
- it picks up when one of the 3 phase-to-neutral voltages drops below the Vs set point
- it has 3 independent outputs available for the control matrix
- it is operational if the number of VTs connected is V1, V2, V3 or U21, U32 with measurement of V0.

Block diagram



Characteristics

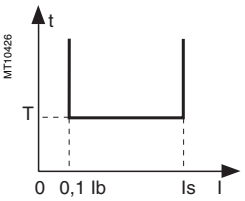
Vs set point	
Setting	5 % Vnp to 100 % Vnp
Accuracy (1)	±2 % or 0.005 Vnp
Resolution	1 %
Drop-out/pick-up ratio	103 % ±2.5 %
Time delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2 %, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times	
Operation time	pick-up < 35 ms (typically 25 ms)
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*

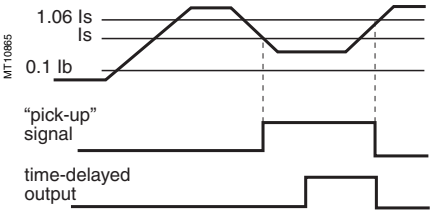
Phase undercurrent
ANSI code 37

Operation

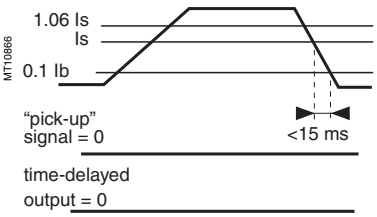
This protection is single-phase:
- it picks up when phase 1 current drops below the Is set point
- it is inactive when the current is less than 10 % of Ib
- it is insensitive to current drops (breaking) due to circuit breaker tripping
- it includes a definite time delay T.



Operating principle

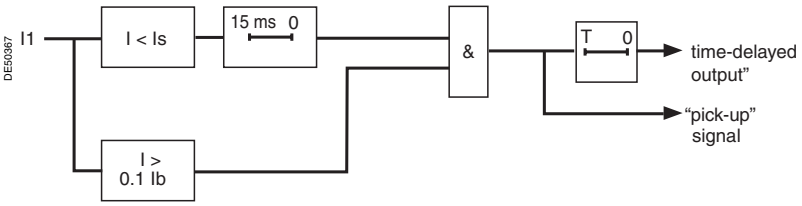


Case of current sag.



Case of circuit breaker tripping.

Block diagram



Characteristics

Is set point	
Setting	15 % Ib ⩽ Is ⩽ 100 % Ib by steps of 1 %
Accuracy (1)	±5 %
Pick-up/drop-out ratio	106 % ±5 % for Is > 0.1 In
T time delay	
Setting	50 ms ⩽ T ⩽ 300 s
Accuracy (1)	±2 % or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times	
Operating time	< 50 ms
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*

Temperature monitoring
ANSI code 38/49T

Operation

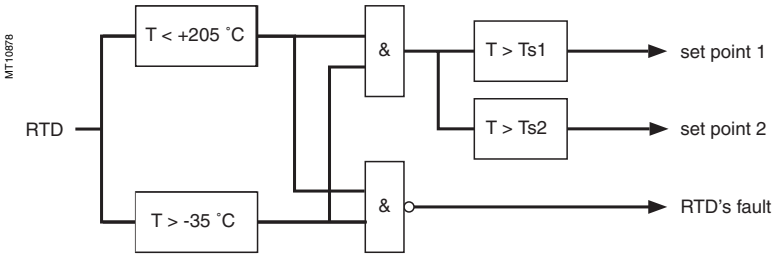
This protection is associated with an RTD of the Pt100 platinum (100 Ω at 0 °C) or (nickel 100 Ω, nickel 120 Ω) type in accordance with the IEC 60751 and DIN 43760 standards.

- it picks up when the monitored temperature is greater than the Ts set point
- it has two independent set points:
  - alarm set point
  - tripping set point
- when the protection is activated, it detects whether the RTD is shorted or disconnected:
  - RTD shorting is detected if the measured temperature is less than -35 °C (measurement displayed "****")
  - RTD disconnection is detected if the measured temperature is greater than +205 °C (measurement displayed "-****").

If an RTD fault is detected, the set point output relays are inhibited: the protection outputs are set to zero.

The "RTD fault" item is also made available in the control matrix and an alarm message is generated.

Block diagram



Characteristics

Ts1 and Ts2 set points	**°C**	**°F**
Setting	0 °C to 180 °C	32 °F to 356 °F
Accuracy (1)	±1.5 °C	±2.7 °F
Resolution	1 °C	1 °F
Pick-up/drop-out difference	3 °C ±0.5 °	
Characteristic times		
Operation time	< 5 seconds	

***(1)** See "connection of MET148-2 module" chapter for accuracy derating according to wiring cross-section.*

Negative sequence / unbalance
ANSI code 46

Operation

The negative sequence / unbalance protection function:
- picks up if the negative sequence component of phase currents is greater than the operation set point
- it is time-delayed. The time delay may be definite time or IDMT (see curve).

The negative sequence current is determined according to the 3 phase currents.

$$\vec{Ii} = \frac{1}{3} \times (\vec{I1} + a^2\vec{I2} + a\vec{I3})$$

with $a = e^{j\frac{2\pi}{3}}$

If Sepam is connected to 2 phase current sensors only, the negative sequence current is:

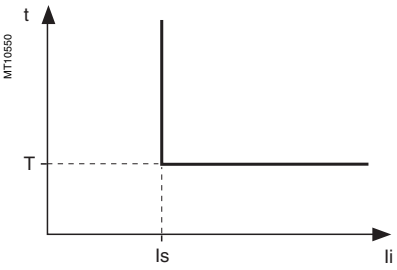
$$\left|\vec{Ii}\right| = \frac{1}{\sqrt{3}} \times \left|\vec{I1} - a^2\vec{I3}\right|$$

with $a = e^{j\frac{2\pi}{3}}$

Both formulas are equivalent when there is no zero sequence current (earth fault).

Definite time protection

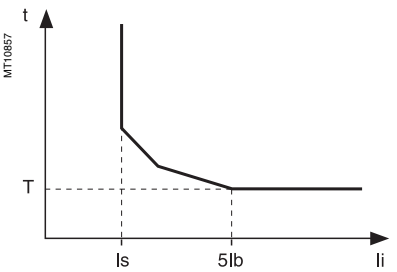
Is is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite time protection principle.

IDMT protection

For Ii > Is, the time delay depends on the value of Ii/Ib (Ib: basis current of the protected equipment defined when the general parameters are set)
T corresponds to the time delay for Ii/Ib = 5.



IDMT protection principle.

The tripping curve is defined according to the following equations:
- for Is/Ib ⩽ Ii/Ib ⩽ 0.

$$t = \frac{3.19}{(Ii/Ib)^{1.5}} . T$$

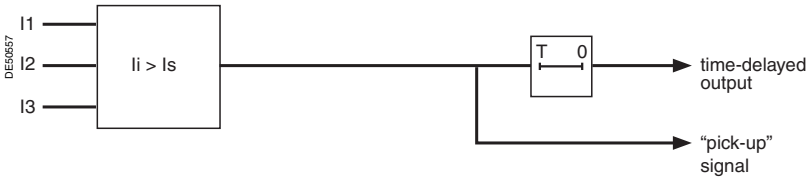
- for 0.5 ⩽ Ii/Ib ⩽ 5

$$t = \frac{4.64}{(Ii/Ib)^{0.96}} . T$$

- for Ii/Ib > 5

$t = T$

Block diagram



Characteristics

Curve		
Setting	Definite, IDMT	
Is set point		
Setting	Definite time	10 % Ib ⩽ Is ⩽ 500 % Ib
	IDMT	10 % Ib ⩽ Is ⩽ 50 % Ib
Resolution		1 %
Accuracy (1)		±5 %
Time delay T (operation time at 5 Ib)		
Setting	Definite time	100 ms ⩽ T ⩽ 300 s
	IDMT	100 ms ⩽ T ⩽ 1 s
Resolution		10 ms ou 1 digit
Accuracy (1)	Definite time	±2 % or ±25 ms
	IDMT	±5 % or ±35 ms
Pick-up/drop-out ratio		93.5 % ±5 %
Characteristic times		
Operation time		pick-up < 55 ms
Overshoot time		< 35 ms
Reset time		< 55 ms

(1) *In reference conditions (IEC 60255-6).*

Negative sequence / unbalance
ANSI code 46

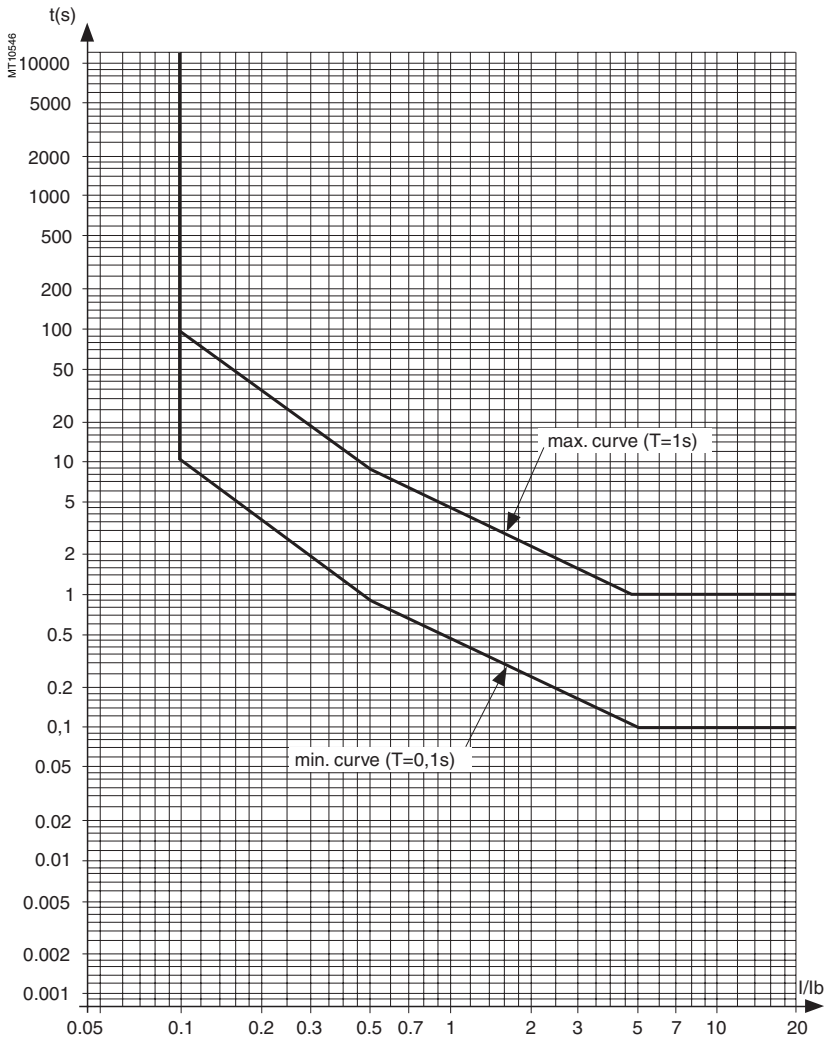
Determination of tripping time for different negative sequence current values for a given curve

Use the table to find the value of K that corresponds to the required negative sequence current. The tripping time is equal to KT.

Example

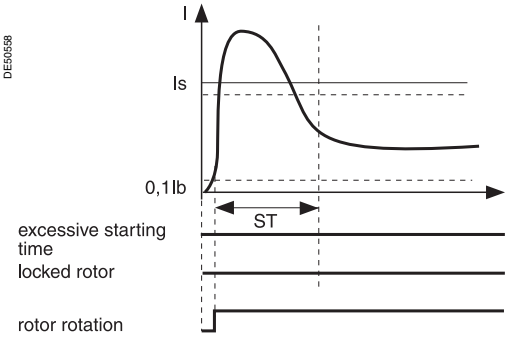
given a tripping curve with the setting T = 0.5 s.
What is the tripping time at 0.6 Ib?
Use the table to find the value of K that corresponds to 60 % of Ib.
The table reads K = 7.55. The tripping time is equal to:
0.5 x 7.55 = 3.755 s.

IDMT tripping curve

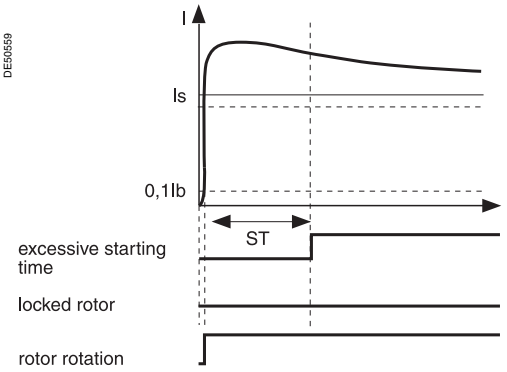


Ii (% Ib)	10	15	20	25	30	33.33	35	40	45	50	55	57.7	60	65	70	75
K	99.95	54.50	35.44	25.38	19.32	16.51	15.34	12.56	10.53	9.00	8.21	7.84	7.55	7.00	6.52	6.11
Ii (% Ib) cont'd	80	85	90	95	100	110	120	130	140	150	160	170	180	190	200	210
K cont'd	5.74	5.42	5.13	4.87	4.64	4.24	3.90	3.61	3.37	3.15	2.96	2.80	2.65	2.52	2.40	2.29
Ii (% Ib) cont'd	22.	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370
K cont'd	2.14	2.10	2.01	1.94	1.86	1.80	1.74	1.68	1.627	1.577	1.53	1.485	1.444	1.404	1.367	1.332
Ii (% Ib) cont'd	380	390	400	410	420	430	440	450	460	470	480	490	⩾ 500			
K cont'd	1.298	1.267	1.236	1.18	1.167	1.154	1.13	1.105	1.082	1.06	1.04	1.02	1			

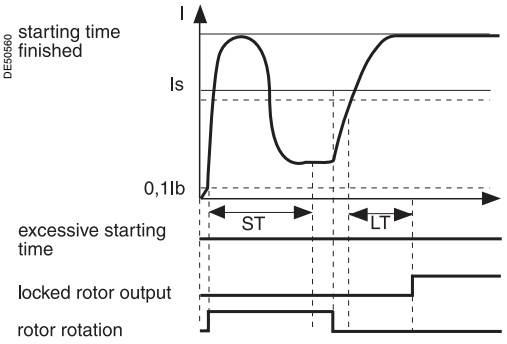
Excessive starting time, locked rotor
ANSI code 48/51LR/14



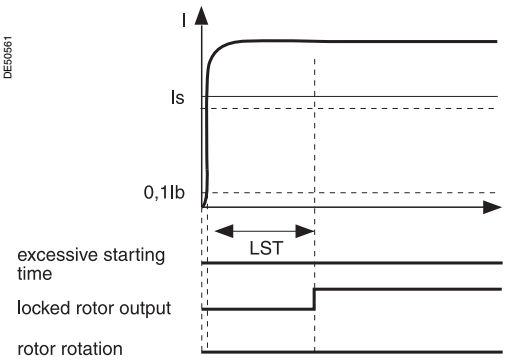
Case of normal starting.



Case of excessive starting time.



Case of locked rotor output.



Case of starting locked rotor.

Operation

This function is three-phase.
It comprises two parts:

- excessive starting time: during starting, the protection picks up when one of the 3 phase currents is greater than the set point Is for a longer period of time than the ST time delay (normal starting time)
- locked rotor:
  - at the normal operating rate (after starting), the protection picks up when one of the 3 phase currents is greater than the set point Is for a longer period of time than the LT time delay of the definite time type
  - locked on start: large motors may have very long starting time, due to their inertia or the reduce voltage supply. This starting time is longer than the permissive rotor blocking time. To protect such a motor LTS timer initiate a trip if a start has been detected (I > Is) or if the motor speed is zero. For a normal start, the input I23 (zero-speed-switch) disable this protection.

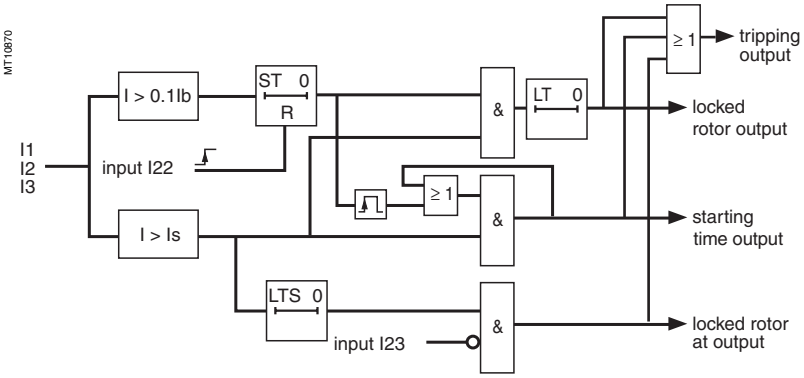
Motor re-acceleration

When the motor re-accelerates, it consumes a current in the vicinity of the starting current (> Is) without the current first passing through a value less than 10 % of Ib. The ST time delay, which corresponds to the normal starting time, may be reinitialized by a logic data input for particular uses (input I22).

- reinitialize the **excessive starting time** protection
- set the **locked rotor** protection LT time delay to a low value.

Starting is detected when the current consumed is 10 % greater than the Ib current.

Block diagram



Characteristics

Is set point		
Setting		50 % Ib ⩽ Is ⩽ 500 % Ib
Resolution		1 %
Accuracy (1)		±5 %
Pick-up/drop-out ratio		93.5 % ±5 %
ST, LT and LTS time delays		
Setting	ST	500 ms ⩽ T ⩽ 300 s
	LT	50 ms ⩽ T ⩽ 300 s
	LTS	50 ms ⩽ T ⩽ 300 s
Resolution		10 ms or 1 digit
Accuracy (1)		±2 % or from -25 ms to +40 ms

***(1)** In reference conditions (IEC 60255-6).*

Thermal overload
ANSI code 49RMS

Description

This function is used to protect equipment (motors, transformers, generators, lines, capacitors) against overloads, based on measurement of the current consumed.

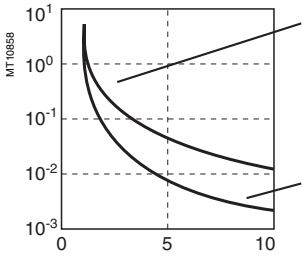
Operation curve

The protection gives a trip order when the heat rise E, calculated according to the measurement of an equivalent current Ieq, is greater than the set point Es. The greatest permissible continuous current is

$$I = Ib\sqrt{Es}$$

The protection tripping time is set by the time constant T.

- the calculated heat rise depends on the current consumed and the previous heat rise state
- the cold curve defines the protection tripping time based on zero heat rise
- the hot curve defines the protection tripping time based on 100 % nominal heat rise.



Cold curve

$$\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{Ib}\right)^2}{\left(\frac{Ieq}{Ib}\right)^2 - Es}$$

Hot curve

$$\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{Ib}\right)^2 - 1}{\left(\frac{Ieq}{Ib}\right)^2 - Es}$$

Alarm set point, tripping set point

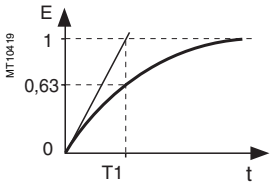
Two set points may be set for heat rise:

- Es1: alarm
- Es2: tripping.

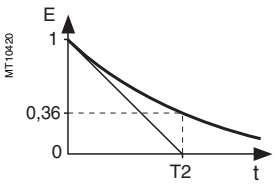
"Hot state" set point

When the function is used to protect a motor, this fixed set point is designed for detection of the hot state used by the number of starts function.

Heat rise and cooling time constants



Heat rise time constant.



Cooling time constant.

For self-ventilated rotating machines, cooling is more effective when the machine is running than when it is stopped. Running and stopping of the equipment are calculated from the value of the current:

- running if I > 0.1 Ib
- stopped if I < 0.1 Ib.

Two time constants may be set:

- T1: heat rise time constant: concerns equipment that is running
- T2: cooling time constant: concerns equipment that is stopped.

Accounting for harmonics

The current measured by the thermal protection is an RMS 3-phase current which takes into account harmonics up to number 17.

Accounting for ambient temperature

Most machines are designed to operate at a maximum ambient temperature of 40 °C. The thermal overload function takes into account the ambient temperature (Sepam equipped with the temperature sensor option (1)) to increase the calculated heat rise value when the temperature measured exceeds 40 °C.

Increase factor: $fa = \frac{Tmax - 40°C}{Tmax - Tambient}$

in which T max is the equipment's maximum temperature (according to insulation class)
T ambient is the measured temperature.

(1) *MET148-2 module, RTC 8 predefined for ambient temperature measurement.*

Adaptation of the protection to motor thermal withstand

Motor thermal protection is often set based on the hot and cold curves supplied by the machine manufacturer. To fully comply with these experimental curves, additional parameters must be set:

- initial heat rise, Es0, is used to reduce the cold tripping time.

modified cold curve: $\frac{t}{T} = Ln\frac{\left(\frac{Ieq}{Ib}\right)^2 - Es0}{\left(\frac{Ieq}{Ib}\right)^2 - Es}$

- a second group of parameters (time constants and set points) is used to take into account thermal withstand with locked rotors. This second set of parameters is taken into account when the current is greater than an adjustable set point Is.

Accounting for negative sequence current

In the case of motors with coiled rotors, the presence of a negative sequence component increases the heat rise in the motor. The negative sequence component of the current is taken into account in the protection by the equation

$Ieq = \sqrt{Iph^2 + K \cdot Ii^2}$ in which Iph is the greatest phase current
Ii is the negative sequence component of the current
K is an adjustable factor

K may have the following values: 0 - 2.25 - 4.5 - 9

For an asynchronous motor, K is determined as follows:

$K = 2 \cdot \frac{Cd}{Cn} \cdot \frac{1}{g \cdot \left(\frac{Id}{Ib}\right)^2} - 1$ in which Cn, Cd: rated torque and starting torque
Ib, Id: basis current and starting current
g: rated slip.

Saving of heat rise

When the protection trips, the current heat rise, increased by 10 %, is saved (Increasing by 10 % makes it possible to take into account the average heat rise of motors when starting). The saved value is reset to zero when the heat rise decreases sufficiently for the time before starting to be zero. The saved value is used when the power returns after a Sepam power failure, so as to start up again with the heat rise that triggered tripping.

Thermal overload
ANSI code 49RMS

Start inhibit
The thermal overload protection can inhibit the closing of the motor's control device until the heat rise drops back down below a value that allows restarting.
This value takes into account the heat rise produced by the motor when starting.
The inhibition function is grouped together with the **starts per hour** protection and the indication START INHIBIT informs the user.

Inhibition of the thermal overload protection function
Tripping of the thermal overload protection function (in the case of a motor) may be locked out, when required by the process, by:
- logic input I26
- remote control order TC7 (inhibit thermal overload protection).

Remote control order TC13 may be used to enable the operation of the thermal overload protection function.

Taking into account 2 transformer operating rates
Power transformers often have two ventilation operating rates:
- ONAN (Oil Natural, Air Natural)
- ONAF (Oil Natural, Air Forced).

The two groups of thermal overload protection parameters enable both of these operating rates to be taken into account.
Switching from one group of thermal settings to the other is controlled by logic input I26.
Switching is carried out without any loss of the thermal capacity used value.

Taking into account 2 motor operating rates
Switching from one set of thermal settings to the other is controlled by.
- logic input I26
- overrun of a set point by the equivalent current.

The 2 groups of thermal overload protection parameters enable both operating rates to be taken into account.
Switching is carried out without any loss of the thermal capacity used value.

User information
The following information is available for the user:
- time before restart enabled (in case of inhibition of starting)
- time before tripping (with constant current)
- heat rise.

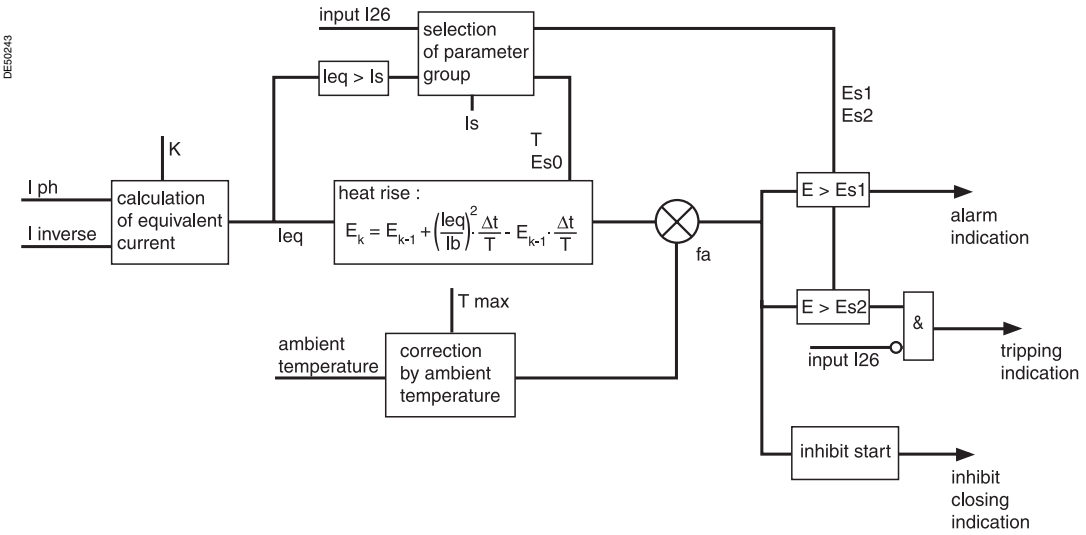
See chapter "Machine operation assistance functions".

Characteristics

Set points		**group A**	**group B**
Setting	Es1 alarm set point	50 % to 300 %	50 % to 300 %
	Es2 tripping set point	50 % to 300 %	50 % to 300 %
	Es0 initial heat rise	0 to 100 %	0 to 100 %
Resolution		1 %	1 %
Time constants			
Setting	T1 running (heat rise)	1 mn to 120 mn	1 mn to 120 mn
	T2 stopped (cooling)	5 mn to 600 mn	5 mn to 600 mn
Resolution		1 mn	1 mn
Accounting for negative sequence component			
Setting	K 0 – 2.25 – 4.5 – 9		
Maximum equipment temperature (according to insulation class) (2)			
Setting	T max 60° to 200°		
Resolution	1°		
RMS current measurement			
Accuracy	5 %		
Tripping time			
Accuracy (1)	2 % or 1 s		
Change of setting parameters			
By current threshold for motor			
Is set point		0.25 to 8 Ib	
By digital input for transformer			
Input		I26	

(1) *In reference conditions (IEC 60255-8).*
(2) *Equipment manufacturer data.*

Block diagram



Thermal overload
ANSI code 49RMS
Setting examples

Example 1

The following data are available:
- time constants for on operation T1 and off operation T2:
  - T1 = 25 min
  - T2 = 70 min
- maximum curve in steady state: Imax/Ib = 1.05.

Setting of tripping set point Es2

Es2 = $(Imax/Ib)^2$ = 110 %

Please note: if the motor absorbs a current of 1.05 Ib in steady state, the heat rise calculated by the thermal overload protection will reach 110 %.

Setting of alarm set point Es1

Es1 = 90 % (I/Ib = 0.95).

Knegative: 4.5 (usual value)

The other thermal overload parameters do not need to be set. They are not taken into account by default.

Example 2

The following data are available:
- motor thermal resistance in the form of hot and cold curves (see solid line curves in Figure 1)
- cooling time constant T2
- maximum steady state current: Imax/Ib = 1.05.

Setting of tripping set point Es2

Es2 = $(Imax/Ib)^2$ = 110 %

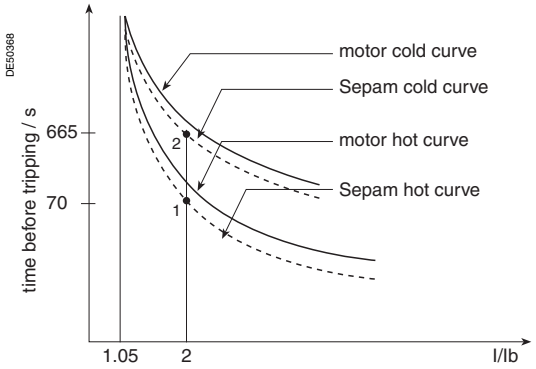
Setting of alarm set point Es1:

Es1 = 90 % (I/Ib = 0.95).

The manufacturer's hot/cold curves (1) may be used to determine the heating time constant T1.

The approach consists of placing the Sepam hot/cold curves below the motor curves.

Figure 1: motor thermal resistance and thermal overload tripping curves



For an overload of 2 Ib, the value t/T1 = 0.0339 (2) is obtained.

In order for Sepam to trip at the point 1 (t = 70 s), T1 is equal to 2065 sec ≈ 34 min.

With a setting of T1 = 34 min, the tripping time is obtained based on a cold state (point 2). In this case, it is equal to t/T1 = 0.3216 ⇒ t⇒ 665 sec, i.e. ≈ 11 min, which is compatible with the thermal resistance of the motor when cold.

The negative sequence factor is calculated using the equation defined on page 3/13.

The parameters of the second thermal overload relay do not need to be set. They are not taken into account by default.

Example 3

The following data are available:
- motor thermal resistance in the form of hot and cold curves (see solid line curves in Figure 1),
- cooling time constant T2
- maximum steady state current: Imax/Ib = 1.1.

Setting of tripping set point Es2

Es2 = $(Imax/Ib)^2$ = 120 %

Setting of alarm set point Es1

Es1 = 90 % (I/Ib = 0.95).

The time constant T1 is calculated so that the thermal overload protection trips after 100 s (point 1).

With t/T1 = 0.069 (I/Ib = 2 and Es2 = 120 %):

⇒ T1 = 100 s / 0.069 = 1449 sec ≈ 24 min.

The tripping time starting from the cold state is equal to:

t/T1 = 0.3567 ⇒ t = 24 min 0.3567 = 513 s (point 2').

This tripping time is too long since the limit for this overload current is 400 s (point 2).

If the time constant T1 is lowered, the thermal overload protection will trip earlier, below point 2.

There risk that motor starting when hot will not be possible also exists in this case (see Figure 2 in which a lower Sepam hot curve would intersect the starting curve with U = 0.9 Un).

The **Es0 parameter** is a setting that is used to solve these differences by lowering the Sepam cold curve without moving the hot curve.

In this example, the thermal overload protection should trip after 400 s starting from the cold state.

The following equation is used to obtain the Es0 value:

$$Es0 = \left[\frac{I_{processed}}{I_b}\right]^2 - e^{\frac{t_{necessary}}{T_1}} \cdot \left[\left[\frac{I_{processed}}{I_b}\right]^2 - Es2\right]$$

with:

$t_{necessary}$: tripping time necessary starting from a cold state.

$I_{processed}$: equipment current.

(1) When the machine manufacturer provides both a time constant T1 and the machine hot/cold curves, the use of the curves is recommended since they are more accurate.

*(2) The charts containing the numerical values of the Sepam **hot curve** may be used, or else the equation of the curve which is given on page 3/13.*

Thermal overload
ANSI code 49RMS
Setting examples

In numerical values, the following is obtained:

$$Es0 = 4 - e^{\frac{400\ sec}{24*60\ sec}} = 0.3035 \approx 31\%$$

By setting Es0 = 31 %, point 2' is moved downward to obtain a shorter tripping time that is compatible with the motor's thermal resistance when cold (see Figure 3).
Please note: A setting Es0 = 100 % therefore means that the hot and cold curves are the same.

Figure 2: hot/cold curves not compatible with the motor's thermal resistance

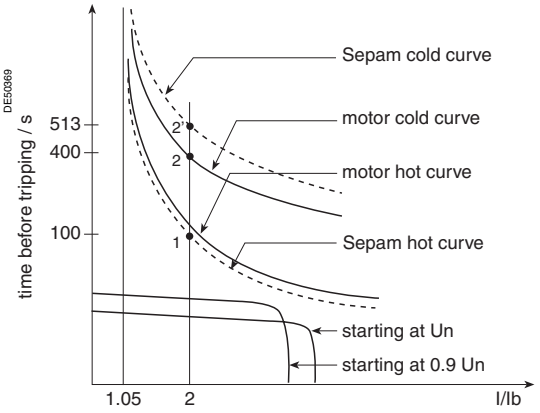
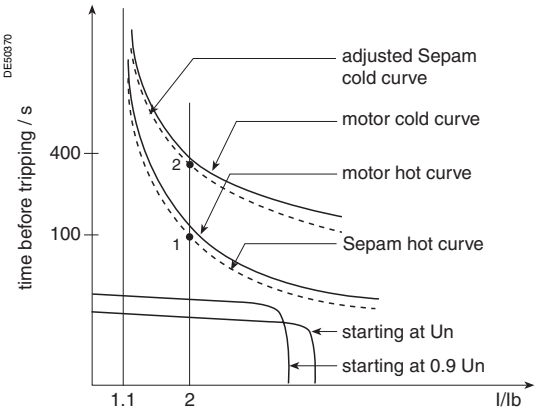
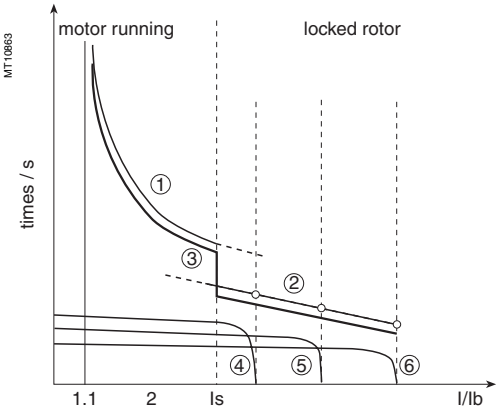


Figure 3: hot/cold curves compatible with the motor's thermal resistance via the setting of an initial heat rise Es0



Use of the additional setting group
When a motor rotor is locked or is turning very slowly, its thermal behavior is different from that with the rated load. In such conditions, the motor is damaged by overheating of the rotor or stator. For high power motors, rotor overheating is most often a limiting factor.
The thermal overload parameters chosen for operation with a low overload are no longer valid.
In order to protect the motor in this case, "excessive starting time" protection may be used.
Nevertheless, motor manufacturers provide the thermal resistance curves when the rotor is locked, for different voltages at the time of starting.

Figure 4: Locked rotor thermal resistance



①: thermal resistance, motor running
②: thermal resistance, motor stopped
③: Sepam tripping curve
④: starting at 65 % Un
⑤: starting at 80 % Un
⑥: starting at 100 % Un

In order to take these curves into account, the second thermal overload relay may be used.
The time constant in this case is, in theory, the shortest one: however, it should not be determined in the same way as that of the first relay.
The thermal overload protection switches between the first and second relay if the equivalent current Ieq exceeds the Is value (set point current).

Thermal overload
ANSI code 49RMS
Setting examples

Cold curves for Es0 = 0 %

I/Ib Es (%)	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
50	0.6931	0.6042	0.5331	0.4749	0.4265	0.3857	0.3508	0.3207	0.2945	0.2716	0.2513	0.2333	0.2173	0.2029	0.1900	0.1782	0.1676
55	0.7985	0.6909	0.6061	0.5376	0.4812	0.4339	0.3937	0.3592	0.3294	0.3033	0.2803	0.2600	0.2419	0.2257	0.2111	0.1980	0.1860
60	0.9163	0.7857	0.6849	0.6046	0.5390	0.4845	0.4386	0.3993	0.3655	0.3360	0.3102	0.2873	0.2671	0.2490	0.2327	0.2181	0.2048
65	1.0498	0.8905	0.7704	0.6763	0.6004	0.5379	0.4855	0.4411	0.4029	0.3698	0.3409	0.3155	0.2929	0.2728	0.2548	0.2386	0.2239
70	1.2040	1.0076	0.8640	0.7535	0.6657	0.5942	0.5348	0.4847	0.4418	0.4049	0.3727	0.3444	0.3194	0.2972	0.2774	0.2595	0.2434
75	1.3863	1.1403	0.9671	0.8373	0.7357	0.6539	0.5866	0.5302	0.4823	0.4412	0.4055	0.3742	0.3467	0.3222	0.3005	0.2809	0.2633
80	1.6094	1.2933	1.0822	0.9287	0.8109	0.7174	0.6413	0.5780	0.5245	0.4788	0.4394	0.4049	0.3747	0.3479	0.3241	0.3028	0.2836
85	1.8971	1.4739	1.2123	1.0292	0.8923	0.7853	0.6991	0.6281	0.5686	0.5180	0.4745	0.4366	0.4035	0.3743	0.3483	0.3251	0.3043
90	2.3026	1.6946	1.3618	1.1411	0.9808	0.8580	0.7605	0.6809	0.6147	0.5587	0.5108	0.4694	0.4332	0.4013	0.3731	0.3480	0.3254
95		1.9782	1.5377	1.2670	1.0780	0,9365	0.8258	0.7366	0.6630	0.6012	0.5486	0.5032	0.4638	0.4292	0.3986	0.3714	0.3470
100		2.3755	1.7513	1.4112	1.1856	1.0217	0.8958	0.7956	0.7138	0.6455	0.5878	0.5383	0.4953	0.4578	0.4247	0.3953	0.3691
105		3.0445	2.0232	1.5796	1.3063	1.1147	0.9710	0.8583	0.7673	0.6920	0.6286	0.5746	0.5279	0,4872	0,4515	0,4199	0,3917
110			2.3979	1.7824	1.4435	1.2174	1.0524	0.9252	0.8238	0.7406	0.6712	0.6122	0.5616	0.5176	0.4790	0.4450	0.4148
115			3.0040	2.0369	1.6025	1.3318	1.1409	0,9970	0.8837	0.7918	0.7156	0.6514	0.5964	0.5489	0.5074	0.4708	0.4384
120				2.3792	1.7918	1.4610	1.2381	1.0742	0.9474	0.8457	0.7621	0.6921	0.6325	0.5812	0.5365	0.4973	0.4626
125				2.9037	2.0254	1.6094	1.3457	1.1580	1.0154	0.9027	0.8109	0.7346	0.6700	0.6146	0.5666	0.5245	0.4874
130					2.3308	1.7838	1.4663	1.2493	1.0885	0.9632	0.8622	0.7789	0.7089	0.6491	0.5975	0.5525	0.5129
135					2.7726	1.9951	1.6035	1.3499	1.1672	1.0275	0.9163	0.8253	0.7494	0.6849	0.6295	0.5813	0.5390
140						2.2634	1.7626	1.4618	1.2528	1.0962	0.9734	0.8740	0.7916	0.7220	0.6625	0.6109	0.5658
145						2.6311	1.9518	1.5877	1.3463	1.1701	1.0341	0.9252	0.8356	0.7606	0.6966	0.6414	0.5934
150						3.2189	2.1855	1.7319	1.4495	1.2498	1.0986	0.9791	0.8817	0.8007	0.7320	0.6729	0.6217
155							2.4908	1.9003	1.5645	1.3364	1.1676	1.0361	0.9301	0.8424	0.7686	0.7055	0.6508
160							2.9327	2.1030	1.6946	1.4313	1.2417	1.0965	0.9808	0.8860	0.8066	0.7391	0.6809
165								2.3576	1.8441	1.5361	1.3218	1.1609	1.0343	0.9316	0.8461	0.7739	0.7118
170								2.6999	2.0200	1.6532	1.4088	1.2296	1.0908	0.9793	0.8873	0.8099	0.7438
175								3.2244	2.2336	1.7858	1.5041	1.3035	1.1507	1.0294	0.9302	0.8473	0.7768
180									2.5055	1.9388	1.6094	1.3832	1.2144	1.0822	0.9751	0.8861	0.8109
185									2.8802	2.1195	1.7272	1.4698	1.2825	1.1379	1.0220	0.9265	0.8463
190									3.4864	2.3401	1.8608	1.5647	1.3555	1.1970	1.0713	0.9687	0.8829
195										2.6237	2.0149	1.6695	1.4343	1.2597	1.1231	1.0126	0.9209
200										3.0210	2.1972	1.7866	1.5198	1.3266	1.1778	1.0586	0.9605

Thermal overload
ANSI code 49RMS
Setting examples

Cold curves for Es0 = 0 %

I/Ib Es (%)	1.85	1.90	1.95	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60
50	0.1579	0.1491	0.1410	0.1335	0.1090	0.0908	0.0768	0.0659	0.0572	0.0501	0.0442	0.0393	0.0352	0.0317	0.0288	0.0262	0.0239
55	0.1752	0.1653	0.1562	0.1479	0.1206	0.1004	0.0849	0.0727	0.0631	0.0552	0.0487	0.0434	0.0388	0.0350	0.0317	0.0288	0.0263
60	0.1927	0.1818	0.1717	0.1625	0.1324	0.1100	0.0929	0.0796	0.069	0.0604	0.0533	0.0474	0.0424	0.0382	0.0346	0.0315	0.0288
65	0.2106	0.1985	0.1875	0.1773	0.1442	0.1197	0.1011	0.0865	0.075	0.0656	0.0579	0.0515	0.0461	0.0415	0.0375	0.0342	0.0312
70	0.2288	0.2156	0.2035	0.1924	0.1562	0.1296	0.1093	0.0935	0.081	0.0708	0.0625	0.0555	0.0497	0.0447	0.0405	0.0368	0.0336
75	0.2474	0.2329	0.2197	0.2076	0.1684	0.1395	0.1176	0.1006	0.087	0.0761	0.0671	0.0596	0.0533	0.0480	0.0434	0.0395	0.0361
80	0.2662	0.2505	0.2362	0.2231	0.1807	0.1495	0.1260	0.1076	0.0931	0.0813	0.0717	0.0637	0.0570	0.0513	0.0464	0.0422	0.0385
85	0.2855	0.2685	0.2530	0.2389	0.1931	0.1597	0.1344	0.1148	0.0992	0.0867	0.0764	0.0678	0.0607	0.0546	0.0494	0.0449	0.0410
90	0.3051	0.2868	0.2701	0.2549	0.2057	0.1699	0.1429	0.1219	0.1054	0.092	0.0811	0.0720	0.0644	0.0579	0.0524	0.0476	0.0435
95	0.3251	0.3054	0.2875	0.2712	0.2185	0.1802	0.1514	0.1292	0.1116	0.0974	0.0858	0.0761	0.0681	0.0612	0.0554	0.0503	0.0459
100	0.3456	0.3244	0.3051	0.2877	0.2314	0.1907	0.1601	0.1365	0.1178	0.1028	0.0905	0.0803	0.0718	0.0645	0.0584	0.0530	0.0484
105	0.3664	0.3437	0.3231	0.3045	0.2445	0.2012	0.1688	0.1438	0.1241	0.1082	0.0952	0.0845	0.0755	0.0679	0.0614	0.0558	0.0509
110	0.3877	0.3634	0.3415	0.3216	0.2578	0.2119	0.1776	0.1512	0.1304	0.1136	0.1000	0.0887	0.0792	0.0712	0.0644	0.0585	0.0534
115	0.4095	0.3835	0.3602	0.3390	0.2713	0.2227	0.1865	0.1586	0.1367	0.1191	0.1048	0.0929	0.0830	0.0746	0.0674	0.0612	0.0559
120	0.4317	0.4041	0.3792	0.3567	0.2849	0.2336	0.1954	0.1661	0.1431	0.1246	0.1096	0.0972	0.0868	0.0780	0.0705	0.0640	0.0584
125	0.4545	0.4250	0.3986	0.3747	0.2988	0.2446	0.2045	0.1737	0.1495	0.1302	0.1144	0.1014	0.0905	0.0813	0.0735	0.0667	0.0609
130	0.4778	0.4465	0.4184	0.3930	0.3128	0.2558	0.2136	0.1813	0.156	0.1358	0.1193	0.1057	0.0943	0.0847	0.0766	0.0695	0.0634
135	0.5016	0.4683	0.4386	0.4117	0.3270	0.2671	0.2228	0.1890	0.1625	0.1414	0.1242	0.1100	0.0982	0.0881	0.0796	0.0723	0.0659
140	0.5260	0.4907	0.4591	0.4308	0.3414	0.2785	0.2321	0.1967	0.1691	0.147	0.1291	0.1143	0.1020	0.0916	0.0827	0.0751	0.0685
145	0.5511	0.5136	0.4802	0.4502	0.3561	0.2900	0.2414	0.2045	0.1757	0.1527	0.1340	0.1187	0.1058	0.0950	0.0858	0.0778	0.0710
150	0.5767	0.5370	0.5017	0.4700	0.3709	0.3017	0.2509	0.2124	0.1823	0.1584	0.1390	0.1230	0.1097	0.0984	0.0889	0.0806	0.0735
155	0.6031	0.5610	0.5236	0.4902	0.3860	0.3135	0.2604	0.2203	0.189	0.1641	0.1440	0.1274	0.1136	0.1019	0.0920	0.0834	0.0761
160	0.6302	0.5856	0.5461	0.5108	0.4013	0.3254	0.2701	0.2283	0.1957	0.1699	0.1490	0.1318	0.1174	0.1054	0.0951	0.0863	0.0786
165	0.6580	0.6108	0.5690	0.5319	0.4169	0.3375	0.2798	0.2363	0.2025	0.1757	0.1540	0.1362	0.1213	0.1088	0.0982	0.0891	0.0812
170	0.6866	0.6366	0.5925	0.5534	0.4327	0.3498	0.2897	0.2444	0.2094	0.1815	0.1591	0.1406	0.1253	0.1123	0.1013	0.0919	0.0838
175	0.7161	0.6631	0.6166	0.5754	0.4487	0.3621	0.2996	0.2526	0.2162	0.1874	0.1641	0.1451	0.1292	0.1158	0.1045	0.0947	0.0863
180	0.7464	0.6904	0.6413	0.5978	0.4651	0.3747	0.3096	0.2608	0.2231	0.1933	0.1693	0.1495	0.1331	0.1193	0.1076	0.0976	0.0889
185	0.7777	0.7184	0.6665	0.6208	0.4816	0.3874	0.3197	0.2691	0.2301	0.1993	0.1744	0.1540	0.1371	0.1229	0.1108	0.1004	0.0915
190	0.8100	0.7472	0.6925	0.6444	0.4985	0.4003	0.3300	0.2775	0.2371	0.2052	0.1796	0.1585	0.1411	0.1264	0.1140	0.1033	0.0941
195	0.8434	0.7769	0.7191	0.6685	0.5157	0.4133	0.3403	0.2860	0.2442	0.2113	0.1847	0.1631	0.1451	0.1300	0.1171	0.1062	0.0967
200	0.8780	0.8075	0.7465	0.6931	0.5331	0.4265	0.3508	0.2945	0.2513	0.2173	0.1900	0.1676	0.1491	0.1335	0.1203	0.1090	0.0993

Thermal overload
ANSI code 49RMS
Setting examples

Cold curves for Es0 = 0 %

I/Ib Es (%)	4.80	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	12.50	15.00	17.50	20.00
50	0.0219	0.0202	0.0167	0.0140	0.0119	0.0103	0.0089	0.0078	0.0069	0.0062	0.0056	0.0050	0.0032	0.0022	0.0016	0.0013
55	0.0242	0.0222	0.0183	0.0154	0.0131	0.0113	0.0098	0.0086	0.0076	0.0068	0.0061	0.0055	0.0035	0.0024	0.0018	0.0014
60	0.0264	0.0243	0.0200	0.0168	0.0143	0.0123	0.0107	0.0094	0.0083	0.0074	0.0067	0.0060	0.0038	0.0027	0.0020	0.0015
65	0.0286	0.0263	0.0217	0.0182	0.0155	0.0134	0.0116	0.0102	0.0090	0.0081	0.0072	0.0065	0.0042	0.0029	0.0021	0.0016
70	0.0309	0.0284	0.0234	0.0196	0.0167	0.0144	0.0125	0.0110	0.0097	0.0087	0.0078	0.0070	0.0045	0.0031	0.0023	0.0018
75	0.0331	0.0305	0.0251	0.0211	0.0179	0.0154	0.0134	0.0118	0.0104	0.0093	0.0083	0.0075	0.0048	0.0033	0.0025	0.0019
80	0.0353	0.0325	0.0268	0.0225	0.0191	0.0165	0.0143	0.0126	0.0111	0.0099	0.0089	0.0080	0.0051	0.0036	0.0026	0.0020
85	0.0376	0.0346	0.0285	0.0239	0.0203	0.0175	0.0152	0.0134	0.0118	0.0105	0.0095	0.0085	0.0055	0.0038	0.0028	0.0021
90	0.0398	0.0367	0.0302	0.0253	0.0215	0.0185	0.0161	0.0142	0.0125	0.0112	0.0100	0.0090	0.0058	0.0040	0.0029	0.0023
95	0.0421	0.0387	0.0319	0.0267	0.0227	0.0196	0.0170	0.0150	0.0132	0.0118	0.0106	0.0095	0.0061	0.0042	0.0031	0.0024
100	0.0444	0.0408	0.0336	0.0282	0.0240	0.0206	0.0179	0.0157	0.0139	0.0124	0.0111	0.0101	0.0064	0.0045	0.0033	0.0025
105	0.0466	0.0429	0.0353	0.0296	0.0252	0.0217	0.0188	0.0165	0.0146	0.0130	0.0117	0.0106	0.0067	0.0047	0.0034	0.0026
110	0.0489	0.0450	0.0370	0.0310	0.0264	0.0227	0.0197	0.0173	0.0153	0.0137	0.0123	0.0111	0.0071	0.0049	0.0036	0.0028
115	0.0512	0.0471	0.0388	0.0325	0.0276	0.0237	0.0207	0.0181	0.0160	0.0143	0.0128	0.0116	0.0074	0.0051	0.0038	0.0029
120	0.0535	0.0492	0.0405	0.0339	0.0288	0.0248	0.0216	0.0189	0.0167	0.0149	0.0134	0.0121	0.0077	0.0053	0.0039	0.0030
125	0.0558	0.0513	0.0422	0.0353	0.0300	0.0258	0.0225	0.0197	0.0175	0.0156	0.0139	0.0126	0.0080	0.0056	0.0041	0.0031
130	0.0581	0.0534	0.0439	0.0368	0.0313	0.0269	0.0234	0.0205	0.0182	0.0162	0.0145	0.0131	0.0084	0.0058	0.0043	0.0033
135	0.0604	0.0555	0.0457	0.0382	0.0325	0.0279	0.0243	0.0213	0.0189	0.0168	0.0151	0.0136	0.0087	0.0060	0.0044	0.0034
140	0.0627	0.0576	0.0474	0.0397	0.0337	0.0290	0.0252	0.0221	0.0196	0.0174	0.0156	0.0141	0.0090	0.0062	0.0046	0.0035
145	0.0650	0.0598	0.0491	0.0411	0.0349	0.0300	0.0261	0.0229	0.0203	0.0181	0.0162	0.0146	0.0093	0.0065	0.0047	0.0036
150	0.0673	0.0619	0.0509	0.0426	0.0361	0.0311	0.0270	0.0237	0.0210	0.0187	0.0168	0.0151	0.0096	0.0067	0.0049	0.0038
155	0.0696	0.0640	0.0526	0.0440	0.0374	0.0321	0.0279	0.0245	0.0217	0.0193	0.0173	0.0156	0.0100	0.0069	0.0051	0.0039
160	0.0720	0.0661	0.0543	0.0455	0.0386	0.0332	0.0289	0.0253	0.0224	0.0200	0.0179	0.0161	0.0103	0.0071	0.0052	0.0040
165	0.0743	0.0683	0.0561	0.0469	0.0398	0.0343	0.0298	0.0261	0.0231	0.0206	0.0185	0.0166	0.0106	0.0074	0.0054	0.0041
170	0.0766	0.0704	0.0578	0.0484	0.0411	0.0353	0.0307	0.0269	0.0238	0.0212	0.0190	0.0171	0.0109	0.0076	0.0056	0.0043
175	0.0790	0.0726	0.0596	0.0498	0.0423	0.0364	0.0316	0.0277	0.0245	0.0218	0.0196	0.0177	0.0113	0.0078	0.0057	0.0044
180	0.0813	0.0747	0.0613	0.0513	0.0435	0.0374	0.0325	0.0285	0.0252	0.0225	0.0201	0.0182	0.0116	0.0080	0.0059	0.0045
185	0.0837	0.0769	0.0631	0.0528	0.0448	0.0385	0.0334	0.0293	0.0259	0.0231	0.0207	0.0187	0.0119	0.0083	0.0061	0.0046
190	0.0861	0.0790	0.0649	0.0542	0.0460	0.0395	0.0344	0.0301	0.0266	0.0237	0.0213	0.0192	0.0122	0.0085	0.0062	0.0048
195	0.0884	0.0812	0.0666	0.0557	0.0473	0.0406	0.0353	0.0309	0.0274	0.0244	0.0218	0.0197	0.0126	0.0087	0.0064	0.0049
200	0.0908	0.0834	0.0684	0.0572	0.0485	0.0417	0.0362	0.0317	0.0281	0.0250	0.0224	0.0202	0.0129	0.0089	0.0066	0.0050

Thermal overload
ANSI code 49RMS
Setting examples

Hot curves

I/Ib Es (%)	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
105		0.6690	0.2719	0.1685	0.1206	0.0931	0.0752	0.0627	0.0535	0.0464	0.0408	0.0363	0.0326	0.0295	0.0268	0.0245	0.0226
110		3.7136	0.6466	0.3712	0.2578	0.1957	0.1566	0.1296	0.1100	0.0951	0.0834	0.0740	0.0662	0.0598	0.0544	0.0497	0.0457
115			1.2528	0.6257	0.4169	0.3102	0.2451	0.2013	0.1699	0.1462	0.1278	0.1131	0.1011	0.0911	0.0827	0.0755	0.0693
120			3.0445	0.9680	0.6061	0.4394	0.3423	0.2786	0.2336	0.2002	0.1744	0.1539	0.1372	0.1234	0.1118	0.1020	0.0935
125				1.4925	0.8398	0.5878	0.4499	0.3623	0.3017	0.2572	0.2231	0.1963	0.1747	0.1568	0.1419	0.1292	0.1183
130				2.6626	1.1451	0.7621	0.5705	0.4537	0.3747	0.3176	0.2744	0.2407	0.2136	0.1914	0.1728	0.1572	0.1438
135					1.5870	0.9734	0.7077	0.5543	0.4535	0.3819	0.3285	0.2871	0.2541	0.2271	0.2048	0.1860	0.1699
140					2.3979	1.2417	0.8668	0.6662	0.5390	0.4507	0.3857	0.3358	0.2963	0.2643	0.2378	0.2156	0.1967
145						1.6094	1.0561	0.7921	0.6325	0.5245	0.4463	0.3869	0.3403	0.3028	0.2719	0.2461	0.2243
150						2.1972	1.2897	0.9362	0.7357	0.6042	0.5108	0.4408	0.3864	0.3429	0.3073	0.2776	0.2526
155						3.8067	1.5950	1.1047	0.8508	0.6909	0.5798	0.4978	0.4347	0.3846	0.3439	0.3102	0.2817
160							2.0369	1.3074	0.9808	0.7857	0.6539	0.5583	0.4855	0.4282	0.3819	0.3438	0.3118
165							2.8478	1.5620	1.1304	0.8905	0.7340	0.6226	0.5390	0.4738	0.4215	0.3786	0.3427
170								1.9042	1.3063	1.0076	0.8210	0.6914	0.5955	0.5215	0.4626	0.4146	0.3747
175								2.4288	1.5198	1.1403	0.9163	0.7652	0.6554	0.5717	0.5055	0.4520	0.4077
180								3.5988	1.7918	1.2933	1.0217	0.8449	0.7191	0.6244	0.5504	0.4908	0.4418
185									2.1665	1.4739	1.1394	0.9316	0.7872	0.6802	0.5974	0.5312	0.4772
190									2.7726	1.6946	1.2730	1.0264	0.8602	0.7392	0.6466	0.5733	0.5138
195									4.5643	1.9782	1.4271	1.1312	0.9390	0.8019	0.6985	0.6173	0.5518
200										2.3755	1.6094	1.2483	1.0245	0.8688	0.7531	0.6633	0.5914

I/Ib Es (%)	1.85	1.90	1.95	2.00	2.20	2.40	2.60	2.80	3.00	3,20	3,40	3.60	3.80	4.00	4.20	4.40	4.60
105	0.0209	0.0193	0.0180	0.0168	0.0131	0.0106	0.0087	0.0073	0.0063	0.0054	0.0047	0.0042	0.0037	0.0033	0.0030	0.0027	0.0025
110	0.0422	0.0391	0.0363	0.0339	0.0264	0.0212	0.0175	0.0147	0.0126	0.0109	0.0095	0.0084	0.0075	0.0067	0.0060	0.0055	0.0050
115	0.0639	0.0592	0.0550	0.0513	0.0398	0.0320	0.0264	0.0222	0.0189	0.0164	0.0143	0.0126	0.0112	0.0101	0.0091	0.0082	0.0075
120	0.0862	0.0797	0.0740	0.0690	0.0535	0.0429	0.0353	0.0297	0.0253	0.0219	0.0191	0.0169	0.0150	0.0134	0.0121	0.0110	0.0100
125	0.1089	0.1007	0.0934	0.0870	0.0673	0.0540	0.0444	0.0372	0.0317	0.0274	0.0240	0.0211	0.0188	0.0168	0.0151	0.0137	0.0125
130	0.1322	0.1221	0.1132	0.1054	0.0813	0.0651	0.0535	0.0449	0.0382	0.0330	0.0288	0.0254	0.0226	0.0202	0.0182	0.0165	0.0150
135	0.1560	0.1440	0.1334	0.1241	0.0956	0.0764	0.0627	0.0525	0.0447	0.0386	0.0337	0.0297	0.0264	0.0236	0.0213	0.0192	0.0175
140	0.1805	0.1664	0.1540	0.1431	0.1100	0.0878	0.0720	0.0603	0.0513	0.0443	0.0386	0.0340	0.0302	0.0270	0.0243	0.0220	0.0200
145	0.2055	0.1892	0.1750	0.1625	0.1246	0.0993	0.0813	0.0681	0.0579	0.0499	0.0435	0.0384	0.0341	0.0305	0.0274	0.0248	0.0226
150	0.2312	0.2127	0.1965	0.1823	0.1395	0.1110	0.0908	0.0759	0.0645	0.0556	0.0485	0.0427	0.0379	0.0339	0.0305	0.0276	0.0251
155	0.2575	0.2366	0.2185	0.2025	0.1546	0.1228	0.1004	0.0838	0.0712	0.0614	0.0535	0.0471	0.0418	0.0374	0.0336	0.0304	0.0277
160	0.2846	0.2612	0.2409	0.2231	0.1699	0.1347	0.1100	0.0918	0.0780	0.0671	0.0585	0.0515	0.0457	0.0408	0.0367	0.0332	0.0302
165	0.3124	0.2864	0.2639	0.2442	0.1855	0.1468	0.1197	0.0999	0.0847	0.0729	0.0635	0.0559	0.0496	0.0443	0.0398	0.0360	0.0328
170	0.3410	0.3122	0.2874	0.2657	0.2012	0.1591	0.1296	0.1080	0.0916	0.0788	0.0686	0.0603	0.0535	0.0478	0.0430	0.0389	0.0353
175	0.3705	0.3388	0.3115	0.2877	0.2173	0.1715	0.1395	0.1161	0.0984	0.0847	0.0737	0.0648	0.0574	0.0513	0.0461	0.0417	0.0379
180	0.4008	0.3660	0.3361	0.3102	0.2336	0.1840	0.1495	0.1244	0.1054	0.0906	0.0788	0.0692	0.0614	0.0548	0.0493	0.0446	0.0405
185	0.4321	0.3940	0.3614	0.3331	0.2502	0.1967	0.1597	0.1327	0.1123	0.0965	0.0839	0.0737	0.0653	0.0583	0.0524	0.0474	0.0431
190	0.4644	0.4229	0.3873	0.3567	0.2671	0.2096	0.1699	0.1411	0.1193	0.1025	0.0891	0.0782	0.0693	0.0619	0.0556	0.0503	0.0457
195	0.4978	0.4525	0.4140	0.3808	0.2842	0.2226	0.1802	0.1495	0.1264	0.1085	0.0943	0.0828	0.0733	0.0654	0.0588	0.0531	0.0483
200	0.5324	0.4831	0.4413	0.4055	0.3017	0.2358	0.1907	0.1581	0.1335	0.1145	0.0995	0.0873	0.0773	0.0690	0.0620	0.0560	0.0509

Thermal overload
ANSI code 49RMS
Setting examples

Hot curves

I/Ib Es (%)	4.80	5.00	5.50	6.00	6.50	7.00	7.50	8.00	8.50	9.00	9.50	10.00	12.50	15.00	17.50	20.00
105	0.0023	0.0021	0.0017	0.0014	0.0012	0.0010	0.0009	0.0008	0.0007	0.0006	0.0006	0.0005	0.0003	0.0002	0.0002	0.0001
110	0.0045	0.0042	0.0034	0.0029	0.0024	0.0021	0.0018	0.0016	0.0014	0.0013	0.0011	0.0010	0.0006	0.0004	0.0003	0.0003
115	0.0068	0.0063	0.0051	0.0043	0.0036	0.0031	0.0027	0.0024	0.0021	0.0019	0.0017	0.0015	0.0010	0.0007	0.0005	0.0004
120	0.0091	0.0084	0.0069	0.0057	0.0049	0.0042	0.0036	0.0032	0.0028	0.0025	0.0022	0.0020	0.0013	0.0009	0.0007	0.0005
125	0.0114	0.0105	0.0086	0.0072	0.0061	0.0052	0.0045	0.0040	0.0035	0.0031	0.0028	0.0025	0.0016	0.0011	0.0008	0.0006
130	0.0137	0.0126	0.0103	0.0086	0.0073	0.0063	0.0054	0.0048	0.0042	0.0038	0.0034	0.0030	0.0019	0.0013	0.0010	0.0008
135	0.0160	0.0147	0.0120	0.0101	0.0085	0.0073	0.0064	0.0056	0.0049	0.0044	0.0039	0.0035	0.0023	0.0016	0.0011	0.0009
140	0.0183	0.0168	0.0138	0.0115	0.0097	0.0084	0.0073	0.0064	0.0056	0.0050	0.0045	0.0040	0.0026	0.0018	0.0013	0.0010
145	0.0206	0.0189	0.0155	0.0129	0.0110	0.0094	0.0082	0.0072	0.0063	0.0056	0.0051	0.0046	0.0029	0.0020	0.0015	0.0011
150	0.0229	0.0211	0.0172	0.0144	0.0122	0.0105	0.0091	0.0080	0.0070	0.0063	0.0056	0.0051	0.0032	0.0022	0.0016	0.0013
155	0.0253	0.0232	0.0190	0.0158	0.0134	0.0115	0.0100	0.0088	0.0077	0.0069	0.0062	0.0056	0.0035	0.0025	0.0018	0.0014
160	0.0276	0.0253	0.0207	0.0173	0.0147	0.0126	0.0109	0.0096	0.0085	0.0075	0.0067	0.0061	0.0039	0.0027	0.0020	0.0015
165	0.0299	0.0275	0.0225	0.0187	0.0159	0.0136	0.0118	0.0104	0.0092	0.0082	0.0073	0.0066	0.0042	0.0029	0.0021	0.0016
170	0.0323	0.0296	0.0242	0.0202	0.0171	0.0147	0.0128	0.0112	0.0099	0.0088	0.0079	0.0071	0.0045	0.0031	0.0023	0.0018
175	0.0346	0.0317	0.0260	0.0217	0.0183	0.0157	0.0137	0.0120	0.0106	0.0094	0.0084	0.0076	0.0048	0.0034	0.0025	0.0019
180	0.0370	0.0339	0.0277	0.0231	0.0196	0.0168	0.0146	0.0128	0.0113	0.0101	0.0090	0.0081	0.0052	0.0036	0.0026	0.0020
185	0.0393	0.0361	0.0295	0.0246	0.0208	0.0179	0.0155	0.0136	0.0120	0.0107	0.0096	0.0086	0.0055	0.0038	0.0028	0.0021
190	0.0417	0.0382	0.0313	0.0261	0.0221	0.0189	0.0164	0.0144	0.0127	0.0113	0.0101	0.0091	0.0058	0.0040	0.0030	0.0023
195	0.0441	0.0404	0.0330	0.0275	0.0233	0.0200	0.0173	0.0152	0.0134	0.0119	0.0107	0.0096	0.0061	0.0043	0.0031	0.0024
200	0.0464	0.0426	0.0348	0.0290	0.0245	0.0211	0.0183	0.0160	0.0141	0.0126	0.0113	0.0102	0.0065	0.0045	0.0033	0.0025

Phase overcurrent
ANSI code 50/51

Description

The phase overcurrent function comprises 4 independant elements divided into two groups of 2 elements called Group A and Group B respectively. The use of the two groups may be chosen by parameter setting:

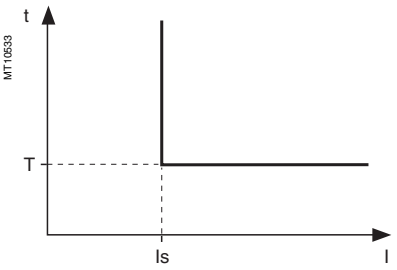
- operation with Group A or Group B exclusively, with switching from one group to the other dependent on the state of logic input I13 exclusively, or by remote control (TC3, TC4),
  I13 = 0 group A
  I13 = 1 group B
- operation with Group A and Group B active for 4-set point operation,
- enabling/disabling of each group of 2 elements (A, B).

Operation

The phase overcurrent protection function is three-pole. It picks up if one, two or three of the phase currents reach the operation set point.
It is time-delayed. The time delay may be definite time (**DT**) or IDMT according to the curves opposite.

Definite time protection

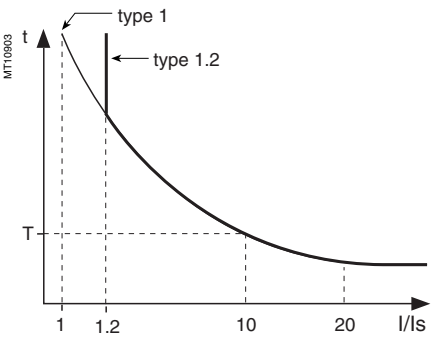
Is is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite time protection principle.

IDMT protection

IDMT protection operates in accordance with the IEC (60255-3), BS 142 and IEEE (C-37112) standards.



IDMT protection principle.

The Is setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is.
The tripping time for I/Is values of less than 1.2 depends on the type of curve chosen.

Name of curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

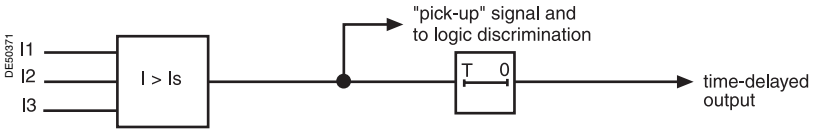
The curve equations are given in the chapter entitled "IDMT protection functions".

The function takes into account current variations during the time delay interval. For currents with a very large amplitude, the protection function has a definite time characteristic:

- if I > 20 Is, tripping time is the time that corresponds to 20 Is
- if I > 40 In, tripping time is the time that corresponds to 40 In.

(In: current transformer rated current defined when the general settings are made).

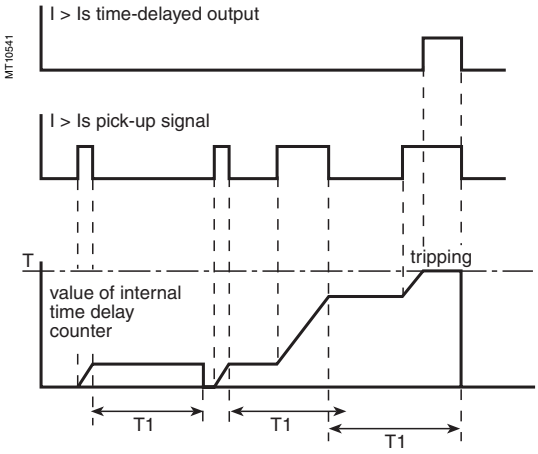
Block diagram



Timer hold delay

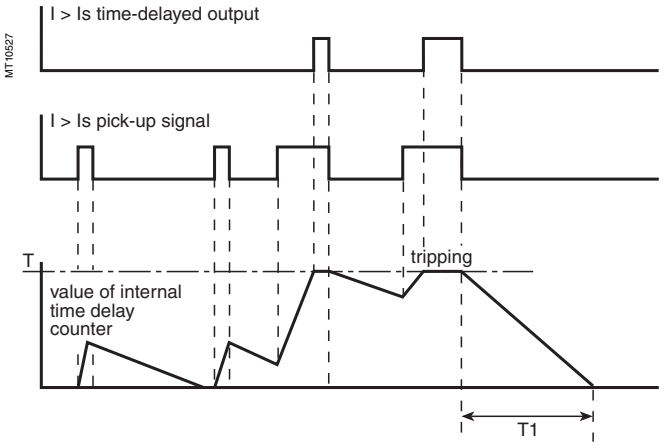
The function includes an adjustable timer hold delay T1:

- definite time (timer hold) for all the tripping curves.



Phase overcurrent
ANSI code 50/51

■ IDMT for IEC, IEEE and IAC curves.



Characteristics

Tripping curve		
Setting		Definite time, IDMT: chosen according to list on previous page
Is set point		
Setting	Definite time	0.1 In ⩽ Is ⩽ 24 In expressed in Amps
	IDMT	0.1 In ⩽ Is ⩽ 2.4 In expressed in Amps
Resolution		1 A or 1 digit
Accuracy (1)		±5 % or ±0.01 In
Drop out/pick-up ratio		93.5 % ±5 % or > (1 - 0.02 In/Is) x 100 %
Time delay T (operation time at 10 Is)		
Setting	Definite time	inst. 50 ms ⩽ T ⩽ 300 s
	IDMT	100 ms ⩽ T ⩽ 12.5 s or TMS (2)
Resolution		10 ms or 1 digit
Accuracy (1)	Definite time	±2 % or from -10 ms to +25 ms
	IDMT	Class 5 or from -10 ms to +25 ms
Timer hold delay T1		
Definite time (timer hold)		0; 0.05 to 300 s
IDMT (reset time) (3)		0.5 to 20 s
Characteristic times		
Operation time		pick-up < 35 ms at 2 Is (typically 25 ms)
		confirmed instantaneous: ■ inst. < 50 ms at 2 Is for Is ⩾ 0.3 In (typically 35 ms) ■ inst. < 70 ms at 2 Is for Is < 0.3 In (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 50 ms (for T1 = 0)

(1) *In reference conditions (IEC 60255-6).*

(2) *Setting ranges in TMS (Time Multiplier Setting) mode*

Inverse (SIT) and IEC SIT/A:	*0.04 to 4.20*
Very inverse (VIT) and IEC VIT/B:	*0.07 to 8.33*
Very inverse (LTI) and IEC LTI/B:	*0.01 to 0.93*
Ext inverse (EIT) and IEC EIT/C:	*0.13 to 15.47*
IEEE moderately inverse:	*0.42 to 51.86*
IEEE very inverse:	*0.73 to 90.57*
IEEE extremely inverse:	*1.24 to 154.32*
IAC inverse:	*0.34 to 42.08*
IAC very inverse:	*0.61 to 75.75*
IAC extremely inverse:	*1.08 to 134.4*

(3) *Only for standardized tripping curves of the IEC, IEEE and IAC types.*

Earth fault
ANSI code 50N/51N or 50G/51G

Description

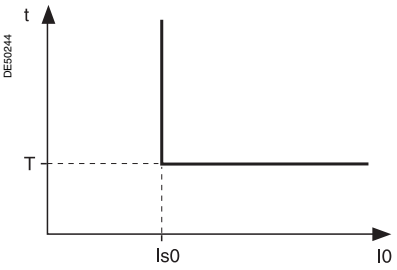
The earth fault function comprises 4 independant elements divided into two groups of 2 settings called Group A and Group B respectively.
The use of the two elements may be chosen by parameter setting:
■ operation with Group A or Group B exclusively, with switching from one group to the other dependent on the state of logic input I13 exclusively, or by remote control (TC3, TC4),
I13 = 0 group A
I13 = 1 group B
■ operation with Group A and Group B active for 4-set point operation
■ enabling/disabling of each group of 2 elements (A, B).

Operation

The earth fault protection function is single-pole.
It picks up if the earth fault current reaches the operation set point.
It is time-delayed. The time delay may be definite time (**DT**) or IDMT according to the curves opposite.
The protection function includes harmonic 2 restraint which provides greater stability when transformers are energized (measurement of residual current by the sum of the 3 phase CTs).
The restraint disables tripping, regardless of the fundamental current.
The restraint may be inhibited by parameter setting.

Definite time protection

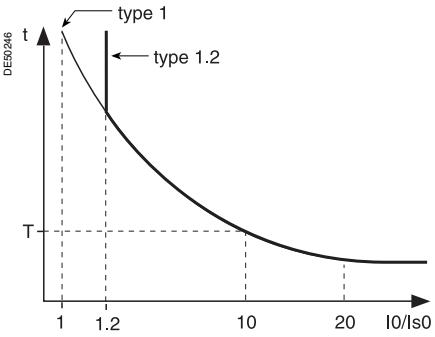
Is0 is the operation set point expressed in Amps, and T is the protection operation time delay.



Definite time protection principle.

IDMT protection

IDMT protection operates in accordance with the IEC (60255-3), BS 142 and IEEE (C-37112) standards.



IDMT protection principle.

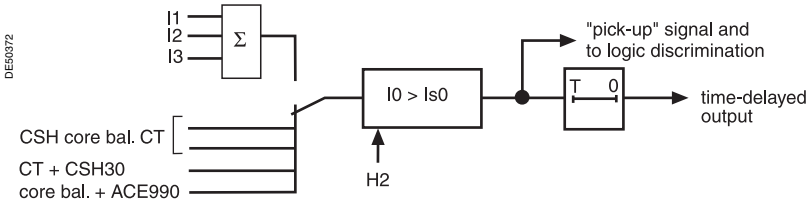
The Is0 setting is the vertical asymptote of the curve, and T is the operation time delay for 10 Is0.
The tripping time for I0/Is0 values of less than 1.2 depends on the type of curve chosen.

Name of curve	Type
Standard inverse time (SIT)	1.2
Very inverse time (VIT or LTI)	1.2
Extremely inverse time (EIT)	1.2
Ultra inverse time (UIT)	1.2
RI curve	1
IEC standard inverse time SIT / A	1
IEC very inverse time VIT or LTI / B	1
IEC extremely inverse time EIT / C	1
IEEE moderately inverse (IEC / D)	1
IEEE very inverse (IEC / E)	1
IEEE extremely inverse (IEC / F)	1
IAC inverse	1
IAC very inverse	1
IAC extremely inverse	1

The curve equations are given in the chapter entitled "IDMT protection functions".

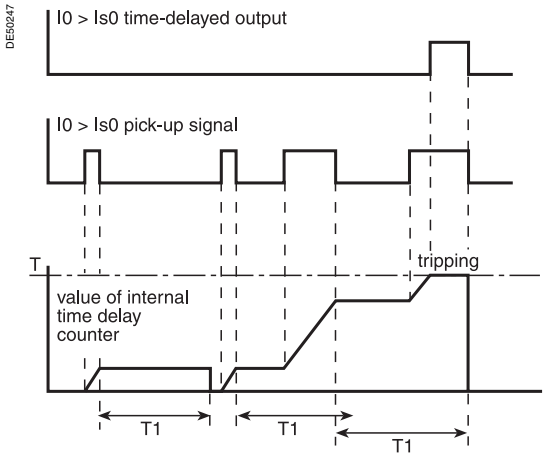
The function takes into account current variations during the time delay interval.
For currents with a very large amplitude, the protection function has a definite time characteristic:
■ if I0 > 20 Is0, tripping time is the time that corresponds to 20 Is0
■ if I0 > 15 In0 (1), tripping time is the time that corresponds to 15 In0.

Block diagram



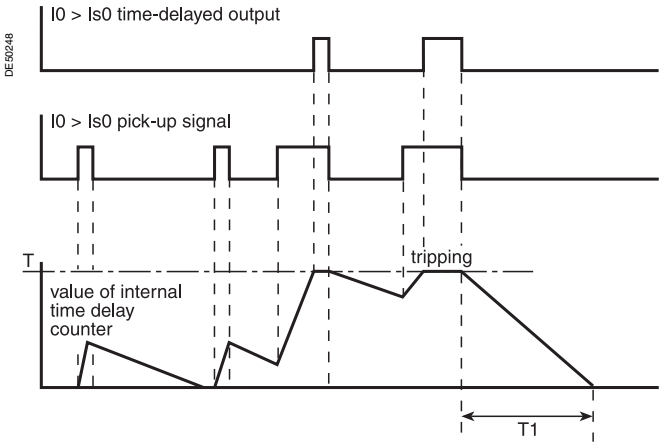
Timer hold delay

The function includes an adjustable timer hold delay T1:
■ definite time (timer hold) for all the tripping curves



Earth fault
ANSI code 50N/51N or 50G/51G

■ IDMT for IEC, IEEE and IAC curves.



Characteristics

Tripping curvet		
Setting		Definite time, IDMT: chosen according to list on previous page
Is0 set point		
Definite time setting		0.1 In0 ⩽ Is0 ⩽ 15 In0 expressed in Amps
	Sum of CTs (1) (5)	0.1 In0 ⩽ Is0 ⩽ 15 In0
	With CSH sensor	
	2 A rating	0.2 A to 30 A
	20 A rating	2 A to 300 A
	CT + CSH30	0.1 In0 ⩽ Is0 ⩽ 15 In0 (min. 0.1 A)
	Core balance CT with ACE990	0.1 In0 < Is0 < 15 In0
IDMT time setting		0.1 In0 ⩽ Is0 ⩽ In0 (1) expressed in Amps
	Sum of CTs (1) (5)	0.1 In0 ⩽ Is0 ⩽ In0
	With CSH sensor	
	2 A rating	0.2 A to 2 A
	20 A rating	2 A to 20 A
	CT + CSH30	0.1 In0 ⩽ Is0 ⩽ In0 (min. 0.1 A)
	Core balance CT with ACE990	0.1 In0 ⩽ Is0 ⩽ In0
Resolution		0.1 A or 1 digit
Accuracy (2)		±5 % or ±0.01 In0
Drop out/pick-up ratio		93.5 % ±5 % (with CSH sensor, CT + CSH30 or core balance CT + ACE990)
		93.5 % ±5 % or > (1 - 0.015 In0/Is0) x 100 % (sum of CTs)
Harmonic 2 restraint		
Fixed threshold		17 % ±5 %
Time delay T (operation time at 10 Is0)		
Setting	Definite time	inst. 50 ms ⩽ T ⩽ 300 s
	IDMT (3)	100 ms ⩽ T ⩽ 12.5 s or TMS (3)
Resolution		10 ms or 1 digit
Accuracy (2)	Definite time	±2 % or from -10 ms to +25 ms
	IDMT	class 5 or from -10 ms to +25 ms
Timer hold delay T1		
Definite time (timer hold)		0; 0.05 to 300 s
IDMT (4)		0.5 to 300 s
Characteristic times		
Operation time		pick-up < 35 ms at 2 Is0 (typically 25 ms)
		confirmed instantaneous: ■ inst. < 50 ms at 2 Is0 for Is0 ⩾ 0.3 In0 (typically 35 ms) ■ inst. < 70 ms at 2 Is0 for Is0 < 0.3 In0 (typically 50 ms)
Overshoot time		< 35 ms
Reset time		< 40 ms (for T1 = 0)

(1) *In0 = In if the sum of the three phase currents is used for the measurement.*
In0 = sensor rating if the measurement is taken by a CSH core balance CT.
In0 = In of the CT if the measurement is taken by a 1 A or 5 A current transformer.

(2) *In reference conditions (IEC 60255-6).*

(3) *Setting ranges in TMS (Time Multiplier Setting) mode*

Inverse (SIT) and IECIEC SIT/A:	*0.04 to 4.20*
Very inverse (VIT) and IEC VIT/B:	*0.07 to 8.33*
Very inverse (LTI) and IEC LTI/B:	*0.01 to 0.93*
Ext inverse (EIT) and IEC EIT/C:	*0.13 to 15.47*
IEEE moderately inverse:	*0.42 to 51.86*
IEEE very inverse:	*0.73 to 90.57*
IEEE extremely inverse:	*1.24 to 154.32*
IAC inverse:	*0.34 to 42.08*
IAC very inverse:	*0.61 to 75.75*
IAC extremely inverse:	*1.08 to 134.4*

(4) *Only for standardized tripping curves of the IEC, IEEE and IAC types.*

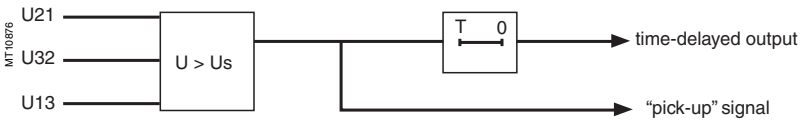
(5) *For Is0 < 0.4 In0, the minimum time delay is 300 ms. If a shorter time delay is needed, use the CT + CSH30 combination.*

Phase-to-phase overvoltage
ANSI code 59

Operation

This protection is three-phase:
- it picks up when one of the phase-to-phase voltages concerned is greater than the Us set point
- the protection includes a definite time delay.

Block diagram



Characteristics

Us set point	
Setting	50 % Unp to 150 % Unp (2)
Accuracy (1)	±2 % or 0.005 Unp
Resolution	1 %
Drop-out/pick-up ratio	97 % ±1 %
Time delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2 %, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times	
Operation time	pick-up < 35 ms (typically 25 ms)
Overshoot time	< 35 ms
Reset time	< 40 ms

(1) *In reference conditions (IEC 60255-6).*
(2) *135 % Unp with TP 230 V / $\sqrt{3}$.*

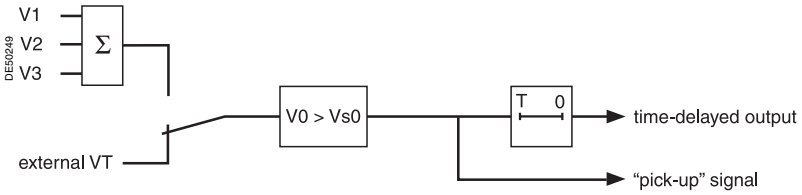
Neutral voltage displacement
ANSI code 59N

Operation

The protection function picks up if the residual voltage V0 is above a Vs0 set point, with $\vec{V0} = \vec{V1} + \vec{V2} + \vec{V3}$,

- it includes a definite time delay T
- the residual voltage is either calculated from the 3 phase voltages or measured by an external VT.

Block diagram



Characteristics

Vs0 set point	
Setting	2 % Unp to 80 % Unp if Vns0 (2) = sum of 3Vs 2 % Unp to 80 % Unp if Vns0 (2) = Uns/$\sqrt{3}$ 5 % Unp to 80 % Unp if Vns0 (2) = Uns/3
Accuracy (1)	±2 % or ±0.005 Unp
Resolution	1 %
Drop-out/pick-up ratio	97 % ±1 %
Time delay T	
Setting	50 ms to 300 s
Accuracy (1)	±2 %, or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times	
Operation time	pick-up < 55 ms
Overshoot time	< 35 ms
Reset time	< 55 ms

(1) *In reference conditions (IEC 60255-6).*

(2) *Vns0 is one of the general settings.*

Starts per hour
ANSI code 66

Operation

This function is three-phase.
It picks up when the number of starts reaches the following limits:
- maximum number of starts allowed per period of time (P) (Nt)
- maximum allowed number of consecutive hot starts (Nh)
- maximum allowed number of consecutive cold starts (Nc).

The function indicates:
- the number of starts still allowed before the maximum, if the protection has not picked up. The number of starts depends on the motor's thermal state
- waiting time before a start is allowed, if the protection has picked up.

Starting is detected when the current consumed becomes greater than 10 % of the Ib current.

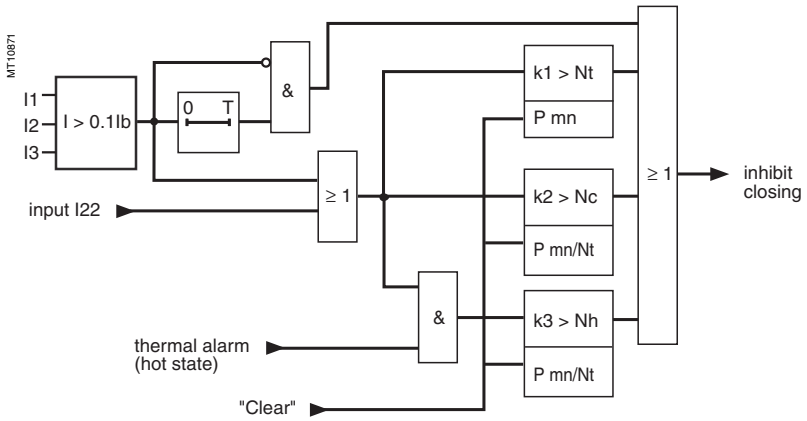
User information

The following information is available for the user:
- the waiting time before a start is allowed
- the number of starts still allowed.

See chapter "Machine operation assistance functions".

The number of consecutive starts is the number starts counted during the last P/Nt minutes, Nt being the number of starts allowed per period.
The motor hot state corresponds to the overshooting of the fixed set point (50 % heat rise) of the thermal overload function.
When the motor re-accelerates, it undergoes a stress similar to that of starting without the current first passing through a value less than 10 % of Ib, in which case the number of starts is not incremented.
It is possible however to increment the number of starts when a re-acceleration occurs by a logic data input (input I22).

Block diagram



Characteristics

Period of time (P)	
Setting	1 to 6 hour
Resolution	1
Nt total number of starts	
Setting	1 to 60
Resolution	1
Nh and Nc number of consecutive starts	
Setting (1)	1 to Nt
Resolution	1
T time delay between starts	
Setting	0 mn ⩽ T ⩽ 90 mn
Resolution	1 mn or 1 digit

(1) *With Nc ⩽ Nf.*

Recloser
ANSI code 79

Operation

Initialization of the recloser

The recloser is ready to operate if all of the following conditions are met:
- "CB control" function activated and recloser in service
- circuit breaker closed
- inhibition time delay not running
- none of the recloser inhibition conditions is true (see further on).

Recloser cycles

- case of a cleared fault:
  - following a reclosing order, if the fault does not appear after the memory time delay has run out, the recloser reinitializes and a message appears on the display (see example 1)
- case of a fault that is not cleared:
  - following instantaneous or time-delayed tripping by the protection unit, activation of the isolation time delay associated with the first active cycle.

At the end of the time delay, a closing order is given, which activates the memory time delay.

If the protection unit detects the fault before the end of the time delay, a tripping order is given and the following reclosing cycle is activated.
- after all the active cycles have been run, if the fault still persists, a final trip order is given, a message appears on the display and closing is locked out until acknowledgment takes place, according to the parameter setting of the protection function
- closing on a fault.

If the circuit breaker closes on a fault, or if the fault appears before the end of the lockout time delay, the recloser is inhibited.

Recloser inhibition conditions

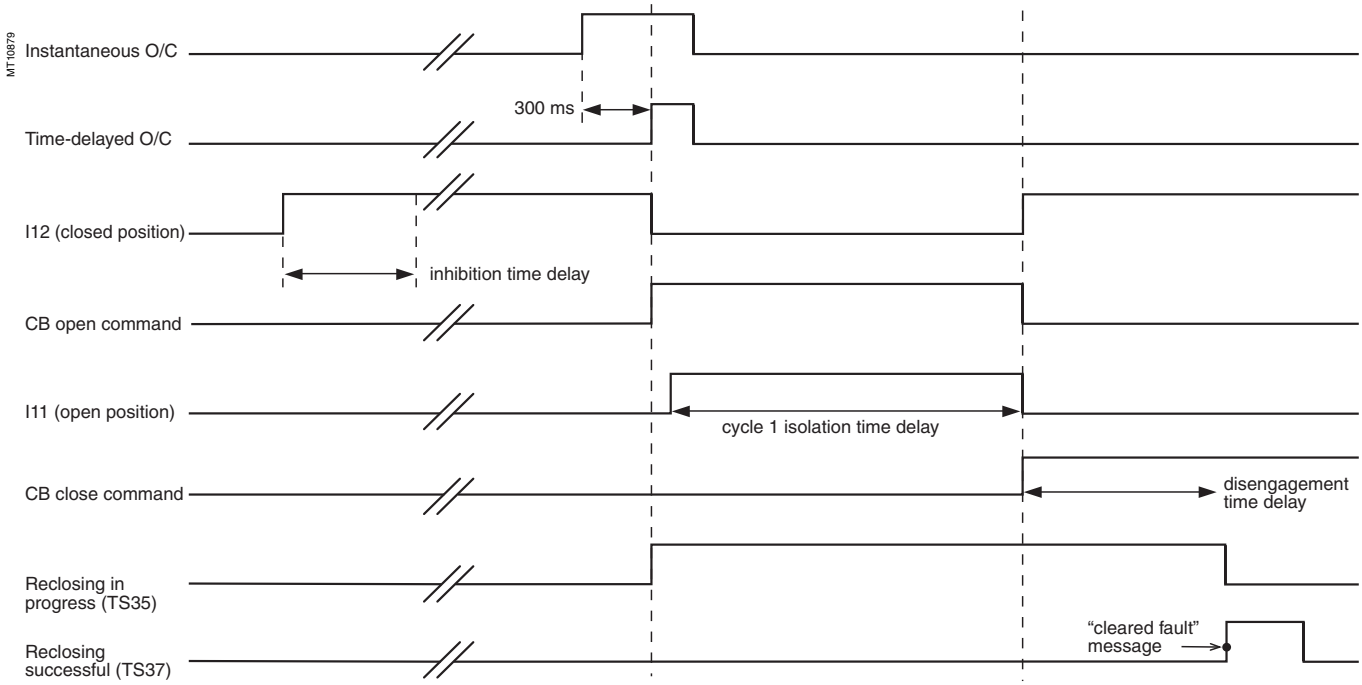
The recloser is inhibited according to the following conditions:
- voluntary open or close order
- recloser put out of service
- receipt of a lockout order on the lockout logic input I26
- appearance of a switchgear-related fault, such as trip circuit fault, or unexecture control order fault
- opening of the circuit breaker by external tripping via inputs I21, I22 or I23.

Characteristics

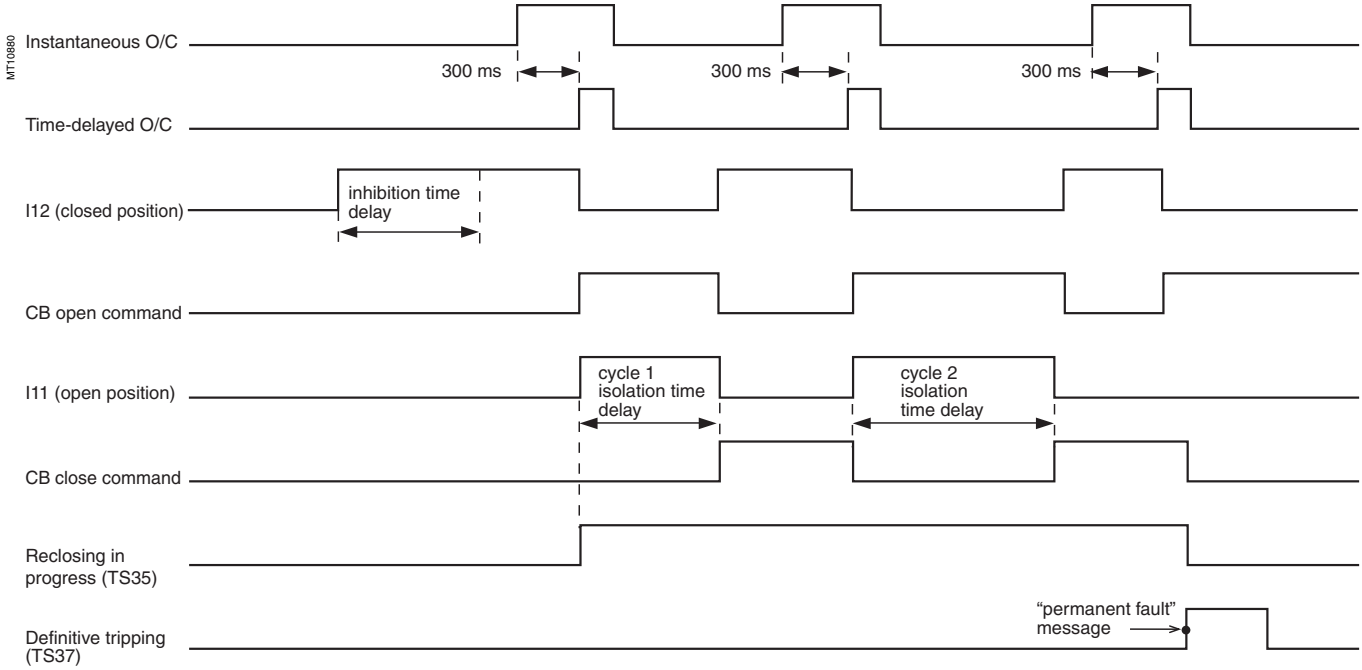
Reclosing cycles			**Setting**
Number of cycles			1 to 4
Activation of cycle 1 (1)		overcurrent 1	inst. / delayed / inactive
		overcurrent 2	inst. / delayed / inactive
		earth fault 1	inst. / delayed / inactive
		earth fault 2	inst. / delayed / inactive
Activation of cycles 2, 3 and 4 (1)		overcurrent 1	inst. / delayed / inactive
		overcurrent 2	inst. / delayed / inactive
		earth fault 1	inst. / delayed / inactive
		earth fault 2	inst. / delayed / inactive
Time delays			
Memory time delay			0.05 to 300 s
Isolation time delay	cycle 1		0.05 to 300 s
	cycle 2		0.05 to 300 s
	cycle 3		0.05 to 300 s
	cycle 4		0.05 to 300 s
Lockout time delay			0.05 to 300 s
Accuracy	±2 % or 25 ms		
Resolution	10 ms or 1 digit		

(1) *If a protection function that is inactive in relation to the recloser leads to circuit breaker opening, the recloser is inhibited.*

Example 1: case of successful reclosing after the first cycle. Activation with 300 ms time-delayed O/C protection



Example 2: case of definitive tripping after two cycles activated by 300 ms time-delayed O/C protection

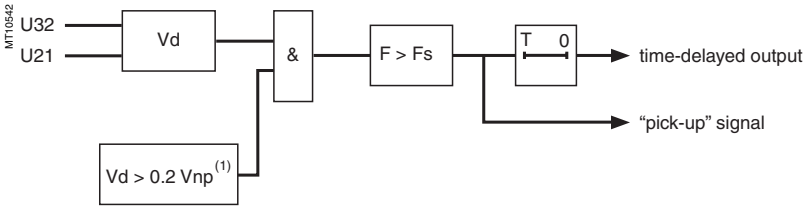


Overfrequency
ANSI code 81H

Operation

The protection function picks up when the positive sequence voltage frequency is above the set point and the positive sequence voltage is more than 20 % of Vnp (Unp/$\sqrt{3}$).
If a single VT is connected (U21), the function picks up when the frequency is higher than the set point and the U21 voltage is more than 20 % of Unp.
It includes a definite time delay T.

Block diagram



(1) *or U21 > 0.2 Unp if only one VT.*

If there is only one sensor (U21), the voltage signal is connected to terminals 1 and 2 of the connector CCT640, whatever the phase.

Characteristics

Fs set point	
Setting	50 to 53 Hz or 60 to 63 Hz
Resolution	0.1 Hz
Accuracy (1)	±0.1 Hz
Pick-up / drop-out difference	0.2 Hz ±0.1 Hz
Time delay T	
Setting	100 ms to 300 s
Accuracy (1)	±2 % or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times (1)	
Operation time	pick-up < 100 ms (typically 80 ms)
Overshoot time	< 100 ms
Reset time	< 100 ms

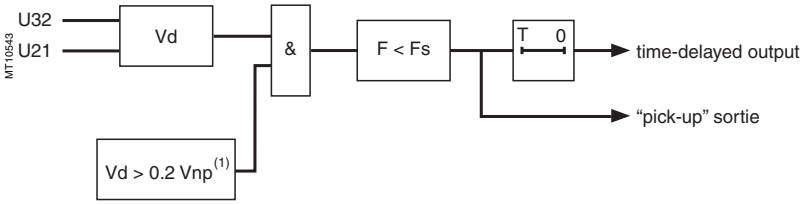
(1) *In reference conditions (IEC 60255-6) and df/dt < 3 Hz/s.*

Underfrequency
ANSI code 81L

Operation

The function picks up when the positive sequence voltage frequency is below the set point and if the negative sequence voltage is more than 20 % of Vnp (Unp/$\sqrt{3}$).
If a single VT is connected (U21), the function picks up when the frequency is below the set point and the U21 voltage is more than 20 % of Unp.
It includes a definite time delay T.

Block diagram



(1) *Or U21 > 0.2 Unp if only one VT.*

If there is only one sensor (U21), the voltage signal is connected to terminals 1 and 2 of the connector CCT640, whatever the phase.

Characteristics

Fs set point	
Setting	45 to 50 Hz or 55 to 60 Hz
Resolution	0.1 Hz
Accuracy (1)	±0.1 Hz
Pick-up / drop-out difference	0.2 Hz ±0.1 Hz
Time delay T	
Setting	100 ms to 300 s
Accuracy (1)	±2 % or ±25 ms
Resolution	10 ms or 1 digit
Characteristic times (1)	
Operation time	pick-up < 100 ms (typically 80 ms)
Overshoot time	< 100 ms
Reset time	< 100 ms

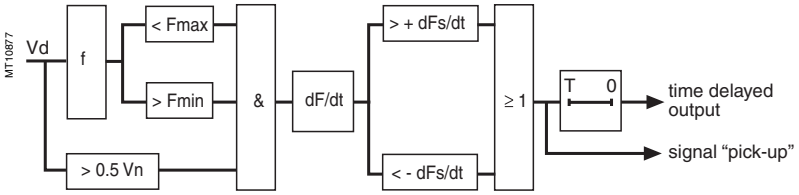
(1) *In reference conditions (IEC 60255-6) and df/dt < 3 Hz/s.*

Rate of change of frequency
ANSI code 81R

Operation

This function picks up when the rate of change of frequency (ROCOF) of the positive sequence voltage overshoots the set point.
If only one VT is connected (U21), the function is inhibited.
It includes a definite time delay T.

Block diagram



Characteristics

dFs/dt set point		
Setting		0.1 to 10 Hz/s
Resolution		0.1 Hz/s
Accuracy	tripping	±5 % or ±0.1 Hz/s
	no tripping	±3 % or ±0.05 Hz/s
Time delay T		
Setting		100 ms to 300 s
Accuracy		±2 % or ±25 ms
Resolution		10 ms or 1 digit
Characteristic times (1)		
Operation time		pick-up < 170 ms (130 ms typical)
Overshoot time		< 100 ms
Reset time		< 100 ms

(1) *In reference conditions (IEC 60255-6).*

General
IDMT protection functions

General

Operation time depends on the type of protection (phase current, earth fault current, …).
Operation is represented by a characteristic curve:
- t = f(I) curve for the **phase overcurrent** function
- t = f(I0) curve for the **earth fault** function.

The rest of the document is based on t = f(I); the reasoning may be extended to other variables I0,…
The curve is defined by:
- type (standard inverse, very inverse, extremely inverse...)
- current setting Is which corresponds to the vertical asymptote of the curve
- time delay T which corresponds to the operation time for I = 10 Is.

These 3 settings are made chronologically in the following order: type, Is current, time delay T.
Changing the time delay T setting by x % changes all of the operation times in the curve by x %.

Examples of problems to be solved

Problem 1
Knowing the type of IDMT, determine the Is current and time delay T settings.
Theoretically, the current setting Is corresponds to the maximum current that may be permanent: it is generally the rated current of the protected equipment (cable, transformer).
The time delay T is set to the operation point at 10 Is on the curve. This setting is determined taking into account the constraints involved in discrimination with the upstream and downstream protection devices.
The discrimination constraint leads to the definition of point A on the operation curve (IA, tA), e.g. the point that corresponds to the maximum fault current affecting the downstream protection device.

Problem 2
Knowing the type of IDMT, the current setting Is and a point k (Ik, tk) on the operation curve, determine the time delay setting T.
On the standard curve of the same type, read the operation time tsk that corresponds to the relative current

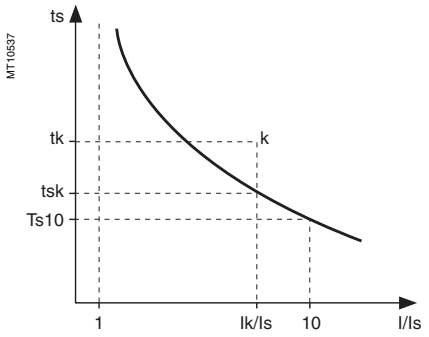
$$\frac{Ik}{Is}$$

and the operation time Ts10 that corresponds to the relative current

$$\frac{I}{Is} = 10$$

The time delay setting that should be made in order for the operation curve to pass through the point k (Ik, tk) is:

$$T = Ts10 \times \frac{tk}{tsk}$$



Another practical method:
The table on the next page gives the values of

$$K = \frac{ts}{ts10} \text{ as a function of } \frac{I}{Is}$$

In the column that corresponds to the type of time delay, read the value $K = \frac{tsk}{Ts10}$ in the line for $\frac{Ik}{Is}$

The time delay setting to be used so that the operation curve passes through the point k (Ik, tk) is: $T = \frac{tk}{k}$

Example
Data:
type of time delay: standard inverse time (**SIT**)
set point: Is
a point k on the operation curve: k (3.5 Is; 4 s)

Question: What is the time delay T setting (operation time at 10 Is)?

Reading of the table: **SIT** column
line $\frac{I}{Is} = 3.5$

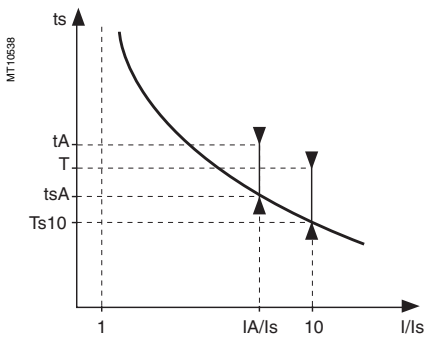
K = 1.86
Answer: The time delay setting is $T = \frac{4}{1.86} = 2.15\ s$

Problem 3
Knowing the current Is and time delay T settings for a type of time delay (standard inverse, very inverse, extremely inverse), find the operation time for a current value of IA.
On the standard curve of the same type, read the operation time tsA that corresponds to the relative current

$$\frac{IA}{Is}$$

and the operation time Ts10 that corresponds to the relative current $\frac{I}{Is} = 10$
The operation time tA for the current IA with the Is and T settings is

$$tA = tsA \times \frac{T}{Ts10}$$



General
IDMT protection functions

Another practical method: the table below gives the values of

$\mathbf{K = \frac{ts}{Ts10}}$ as a function of $\mathbf{\frac{I}{Is}}$

In the column that corresponds to the type of time delay, read the value $\mathbf{K = \frac{tsA}{Ts10}}$

on the line for $\mathbf{\frac{IA}{Is}}$

The operation time tA for the current IA with the Is and T settings is **tA = K. T**

Example
Data:
- type of time delay: very inverse time (**VIT**)
- set point: Is
- time delay T = 0.8 s.

Question: What is the operation time for the current IA = 6 Is?
Reading of the table: **VIT** column

line $\mathbf{\frac{I}{Is} = 6}$

Answer: The operation time for the current IA is t = 1.80 x 0.8 = 1.44 s.

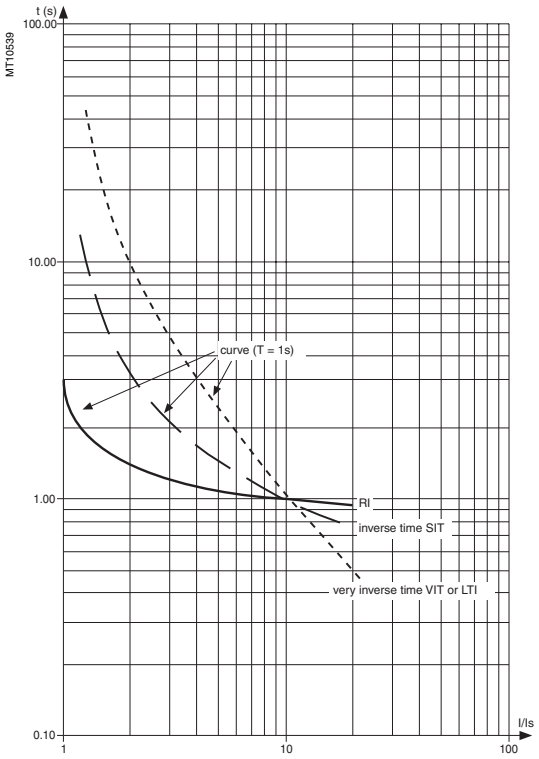
Table of values of K

I/Is	SIT and IEC/A	VIT, LTI and IEC/B	EIT and IEC/C	UIT	RI	IEEE MI (IEC/D)	IEEE VI (IEC/E)	IEEE EI (IEC/F)	IAC I	IAC VI	IAC EI
1.0	—	—	—	—	3.062	—	—	—	62.005	62.272	200.226
1.1	24.700 (1)	90.000 (1)	471.429 (1)	—	2.534	22.461	136.228	330.606	19.033	45.678	122.172
1.2	12.901	45.000	225.000	545.905	2.216	11.777	65.390	157.946	9.413	34.628	82.899
1.5	5.788	18.000	79.200	179.548	1.736	5.336	23.479	55.791	3.891	17.539	36.687
2.0	3.376	9.000	33.000	67.691	1.427	3.152	10.199	23.421	2.524	7.932	16.178
2.5	2.548	6.000	18.857	35.490	1.290	2.402	6.133	13.512	2.056	4.676	9.566
3.0	2.121	4.500	12.375	21.608	1.212	2.016	4.270	8.970	1.792	3.249	6.541
3.5	1.858	3.600	8.800	14.382	1.161	1.777	3.242	6.465	1.617	2.509	4.872
4.0	1.676	3.000	6.600	10.169	1.126	1.613	2.610	4.924	1.491	2.076	3.839
4.5	1.543	2.571	5.143	7.513	1.101	1.492	2.191	3.903	1.396	1.800	3.146
5.0	1.441	2.250	4.125	5.742	1.081	1.399	1.898	3.190	1.321	1.610	2.653
5.5	1.359	2.000	3.385	4.507	1.065	1.325	1.686	2.671	1.261	1.473	2.288
6.0	1.292	1.800	2.829	3.616	1.053	1.264	1.526	2.281	1.211	1.370	2.007
6.5	1.236	1.636	2.400	2.954	1.042	1.213	1.402	1.981	1.170	1.289	1.786
7.0	1.188	1.500	2.063	2.450	1.033	1.170	1.305	1.744	1.135	1.224	1.607
7.5	1.146	1.385	1.792	2.060	1.026	1.132	1.228	1.555	1.105	1.171	1.460
8.0	1.110	1.286	1.571	1.751	1.019	1.099	1.164	1.400	1.078	1.126	1.337
8.5	1.078	1.200	1.390	1.504	1.013	1.070	1.112	1.273	1.055	1.087	1.233
9.0	1.049	1.125	1.238	1.303	1.008	1.044	1.068	1.166	1.035	1.054	1.144
9.5	1.023	1.059	1.109	1.137	1.004	1.021	1.031	1.077	1.016	1.026	1.067
10.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10.5	0.979	0.947	0.906	0.885	0.996	0.981	0.973	0.934	0.985	0.977	0.941
11.0	0.959	0.900	0.825	0.787	0.993	0.963	0.950	0.877	0.972	0.957	0.888
11.5	0.941	0.857	0.754	0.704	0.990	0.947	0.929	0.828	0.960	0.939	0.841
12.0	0.925	0.818	0.692	0.633	0.988	0.932	0.912	0.784	0.949	0.922	0.799
12.5	0.910	0.783	0.638	0.572	0.985	0.918	0.896	0.746	0.938	0.907	0.761
13.0	0.895	0.750	0.589	0.518	0.983	0.905	0.882	0.712	0.929	0.893	0.727
13.5	0.882	0.720	0.546	0.471	0.981	0.893	0.870	0.682	0.920	0.880	0.695
14.0	0.870	0.692	0.508	0.430	0.979	0.882	0.858	0.655	0.912	0.868	0.667
14.5	0.858	0.667	0.473	0.394	0.977	0.871	0.849	0.631	0.905	0.857	0.641
15.0	0.847	0.643	0.442	0.362	0.976	0.861	0.840	0.609	0.898	0.846	0.616
15.5	0.836	0.621	0.414	0.334	0.974	0.852	0.831	0.589	0.891	0.837	0.594
16.0	0.827	0.600	0.388	0.308	0.973	0.843	0.824	0.571	0.885	0.828	0.573
16.5	0.817	0.581	0.365	0.285	0.971	0.834	0.817	0.555	0.879	0.819	0.554
17.0	0.808	0.563	0.344	0.265	0.970	0.826	0.811	0.540	0.874	0.811	0.536
17.5	0.800	0.545	0.324	0.246	0.969	0.819	0.806	0.527	0.869	0.804	0.519
18.0	0.792	0.529	0.307	0.229	0.968	0.812	0.801	0.514	0.864	0.797	0.504
18.5	0.784	0.514	0.290	0.214	0.967	0.805	0.796	0.503	0.860	0.790	0.489
19.0	0.777	0.500	0.275	0.200	0.966	0.798	0.792	0.492	0.855	0.784	0.475
19.5	0.770	0.486	0.261	0.188	0.965	0.792	0.788	0.482	0.851	0.778	0.463
20.0	0.763	0.474	0.248	0.176	0.964	0.786	0.784	0.473	0.848	0.772	0.450

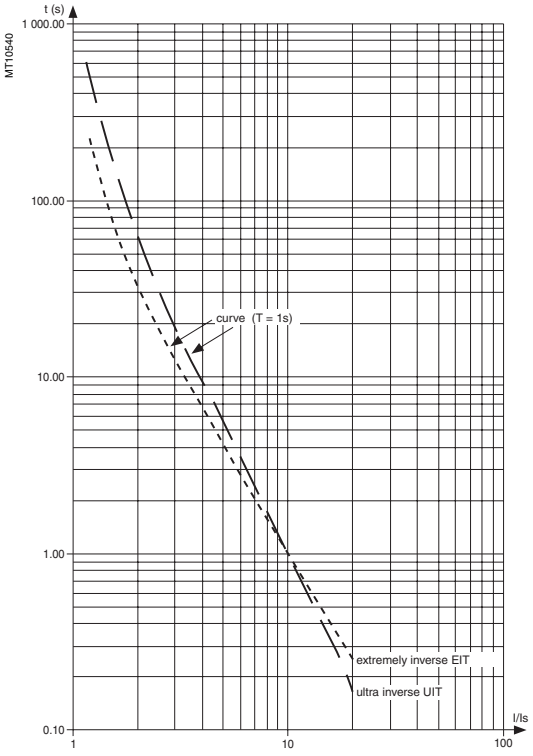
(1) *Values only suitable for IEC A, B and C curves.*

General
IDMT protection functions

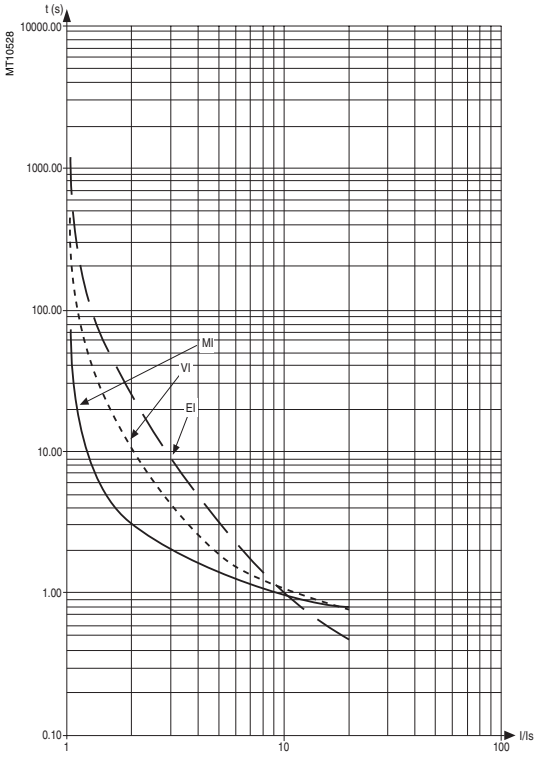
Standard inverse time SIT curve
Very inverse time VIT or LTI curve



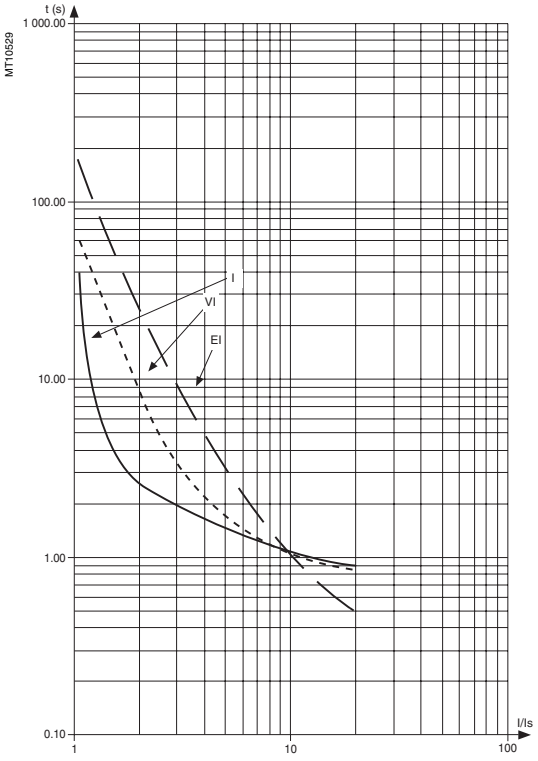
Extremely inverse time EIT curve
Ultra inverse time UIT curve



IEEE curves



IAC curves



General
IDMT protection functions

Curve equations

IEC curve, inverse type

$$t_d(I) = \frac{k}{\left(\frac{I}{Is}\right)^{\alpha} - 1} \times \frac{T}{\beta}$$

IEC curve, RI type

$$t_d(I) = \frac{1}{0.339 - 0.236\left(\frac{I}{I_s}\right)^{-1}} \times \frac{T}{3.1706}$$

IEEE curve

$$t_d(I) = \left(\frac{A}{\left(\frac{I}{I_s}\right)^{P} - 1} + B\right) \times \frac{T}{\beta}$$

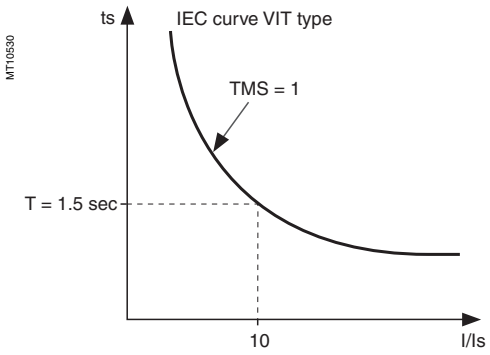
IAC curve

$$t_d(I) = \left(A + \frac{B}{\left(\frac{I}{Is} - C\right)} + \frac{D}{\left(\frac{I}{Is} - C\right)^2} + \frac{E}{\left(\frac{I}{Is} - C\right)^3}\right) x \frac{T}{\beta}$$

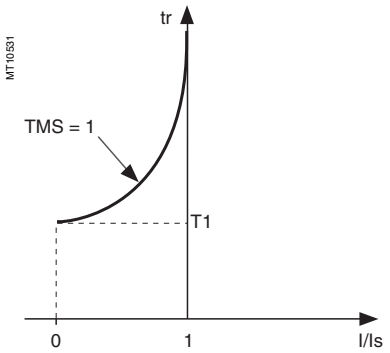
Characteristic curves	k	α	β
IEC standard inverse / A	0.14	0.02	2.97
IEC very inverse / B	13.5	1	1.50
IEC long time inverse / B	120	1	13.33
IEC extremely inverse / C	80	2	0.808
IEC ultra inverse	315.2	2.5	1

Characteristic curves	A	B	p	β
IEEE moderately inverse	0.010	0.023	0.02	0.241
IEEE very inverse	3.922	0.098	2	0.138
IEEE extremely inverse	5.64	0.0243	2	0.081

Characteristic curves	A	B	C	D	E	β
IAC inverse	0.208	0.863	0.800	-0.418	0.195	0.297
IAC very inverse	0.090	0.795	0.100	-1.288	7.958	0.165
IAC extremely inverse	0.004	0.638	0.620	1.787	0.246	0.092



Example: TMS multiplying factor.



Example: IDMT timer hold delay T1.

TMS multiplying factor

The time delay of IDMT tripping curves (except for RI curve) may be set:

- either by T sec (operation time at 10 x Is)
- or by TMS (factor that corresponds to $\frac{T}{\beta}$ in the equations above).

Example :

$$t(I) = \frac{13.5}{\left(\frac{I}{Is}\right) - 1} \times TMS \quad \text{with: } TMS = \frac{T}{1.5}$$

The IEC curve of the VIT type is positioned so as to be the same with TMS = 1 or T = 1.5 sec.

Timer hold delay T1

- definite time:

enables the function to be activated with intermittent faults

- IDMT:

makes it possible to emulate an electromagnetic disk protection relay.

$$t_r(I) = \frac{T1}{1 - \left(\frac{I}{Is}\right)^2} \times \frac{T}{\beta} \text{ with : } \frac{T}{\beta} = TMS$$

T1 = timer hold delay setting (timer hold delay for I reset = 0 and TMS = 1)
T = tripping time delay setting (at 10 Is)
β = basic tripping curve value at **10 Is** = $\frac{k}{10^{\alpha} - 1}$

The standardized or estimated values of T1 are available in the SFT2841 software help.

Contents

Description	**4/2**
Definition of symbols	**4/3**
Assignment of logic inputs / outputs	**4/4**
Circuit breaker / contactor control	**4/5**
Logic discrimination	**4/8**
Disturbance recording triggering **Switching of groups of settings**	**4/10**
Indications	**4/11**
Control matrix	**4/13**

Description

Sepam performs the control and monitoring functions required for electrical network operation.

Predefined functions

The main control and monitoring functions are predefined and fit the most frequent cases of use. They are ready to use and are implemented by simple parameter setting after the necessary logic inputs / outputs are assigned.
The predefined control and monitoring functions can be adapted for particular needs by customization of the control matrix using the SFT2841 software.

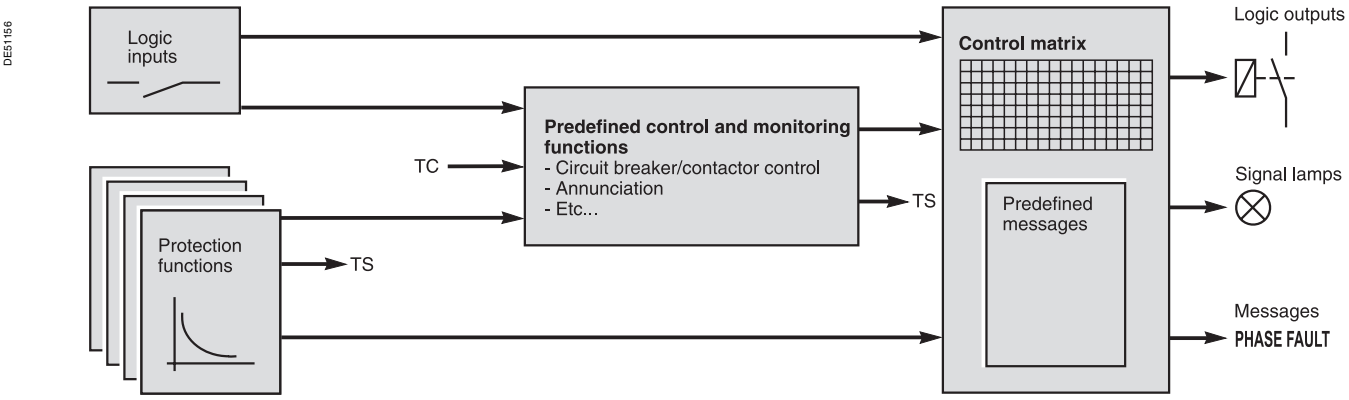
Control matrix

The control matrix is a simple way to assign data from:
- protection functions
- predefined control and monitoring functions
- logic inputs

to the following output data:
- output relays
- 9 LEDs on the front panel of Sepam
- triggering of disturbance recording.

Operating principle

The processing of each control and monitoring function may be broken down into 3 phases:
- acquisition of input data:
  - results of protection function processing
  - external logic data, connected to the logic inputs of an optional MES114 input / output module
  - remote control orders (TC) received via the communication link
- actual processing of the control and monitoring function
- utilization of the processing results:
  - activation of output relays to control an actuator
  - information sent to the facility manager:
    - by message and/or LED on the Sepam display and SFT2841 software
    - by remote indication (TS) via the communication link.



Logic inputs and outputs

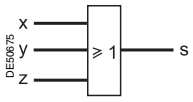
The number of Sepam inputs / outputs must be adapted to fit the control and monitoring functions used.
The 4 outputs included in the Sepam series 20 base unit may be extended by adding one MES114 modules with 10 logic inputs and 4 output relays.
After selecting the MES114 type required by an application, the logic inputs must be assigned to functions.

Definition of symbols

The symbols used in the different block diagrams describing the control and monitoring functions are defined on this page.

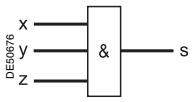
Logic functions

■ **"OR"**



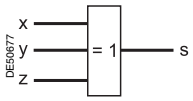
Equation: S = X + Y + Z.

■ **"AND"**



Equation: S = X x Y x Z.

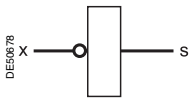
■ **exclusive "XOR"**



S = 1 if one and only one input is set to 1
(S = 1 if X + Y + Z = 1).

■ **Complement**

These functions may use the complement of one or more input values.

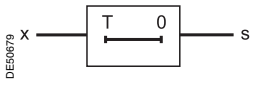


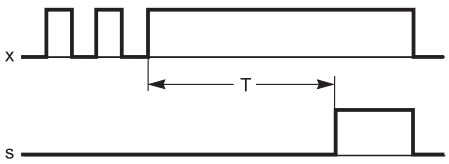
Equation: S = $\overline{X}$ (S = 1 if X = 0).

Delay timers

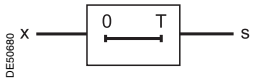
Two types of delay timers:

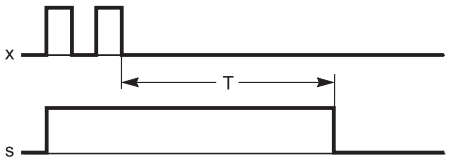
■ "on" delay timer: used to delay the appearance of a signal by a time T





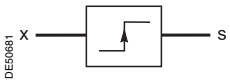
■ "off" delay timer: used to delay the disappearance of a signal by a time T.

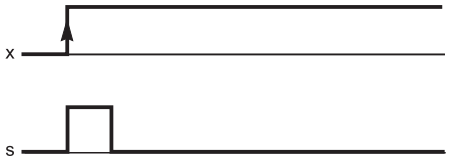




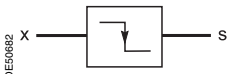
Pulse mode operation

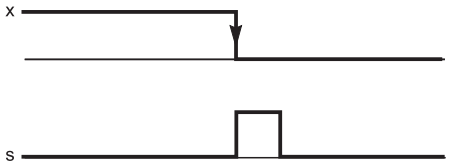
■ "on" pulse: used to create a short-duration pulse (1 cycle) each time a signal appears





■ "off" pulse: used to create a short-duration pulse (1 cycle) each time a signal disappears.

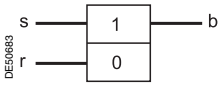


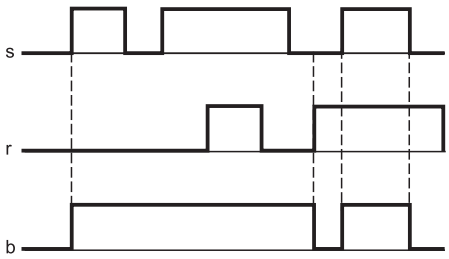


Note: *the disappearance of a signal may be caused by an auxiliary power failure.*

Bistable functions

Bistable functions may be used to store values.





Equation: B = S + $\overline{R}$ x B.

Assignment of logic inputs / outputs

The use of the preset control and monitoring functions requires exclusive parameter setting and particular wiring of the inputs according to their application and the type of Sepam.
The advanced UMI or the SFT2841 software may be used to assign inputs and set the control and monitoring function parameters.
Since an input may only be assigned to a single function, not all the functions are available at the same time.
Example: if the logic discrimination function is used, the switching of groups of settings function may not be used.

Assignment by application chart

Functions	S20	T20	M20	B21 - B22	Assignment
Logic inputs					
Open position	■	■	■	■	I11
Closed position	■	■	■	■	I12
Logic discrimination, receive BL	■	■			I13
Switching of groups of settings A/B	■	■	■		
External reset	■	■	■	■	I14
External tripping 4 (1)	■	■	■	■	
External tripping 1 (1)	■	■ (2)	■	■	I21
External network synchronization	■	■	■	■	
External tripping 2 (1)	■	■ (3)	■	■	I22
Motor reacceleration			■		
External tripping 3 (1)	■	■ (4)	■	■	I23
Buchholz alarm (1) (Buchholz alarm message)		■			
Rotor rotation detection			■		
Thermistor tripping (1)		■	■		
End of charging position	■	■	■		I24
Thermostat alarm (1) (thermostat alarm message)		■			
Thermistor alarm (1)		■	■		
Inhibit remote control (1)	■	■	■	■	I25
SF6-1	■	■	■	■	
SF6-2	■	■	■	■	I26
Change of thermal settings		■	■		
Inhibit thermal overload		■	■		
Inhibit recloser	■				
Logic outputs					
Tripping	■	■	■	■	O1
Inhibit closing	■	■	■	■	O2
Watchdog	■	■	■	■	O4
Closing order	■	■	■	■	O11

Note: *all of the logic inputs are available via the communication link and are accessible in the SFT2841 control matrix for other non predefined applications.*

(1) *These inputs have parameter setting with the prefix "NEG" for undervoltage type operation.*
(2) *Buchholz/Gas trip message.*
(3) *Thermostat trip message.*
(4) *Pressure trip message.*

Circuit breaker / contactor control
ANSI code 94/69

Description

Sepam may be used to control breaking devices equipped with different types of closing and tripping coils.

■ circuit breaker with shut trip or undervoltage tripping coil (parameter set on the front of the advanced UMI or in SFT2841)

■ latching contactor with shunt trip coil.

Two breaking device control modes are available:

■ **use of operating mechanism integrated in the circuit breaker / contactor**

This logical function processes all the circuit breaker closing and tripping conditions based on:

□ breaking device status information

□ remote control orders

□ protection functions

□ specific program logic for each application (e.g. recloser)

□ etc.

This function also inhibits closing of the breaking device according to the operating conditions.

■ **use of customized program logic**

A control and monitoring resource assignment matrix may be used to create customized program logic.

Operating mechanism integrated in the circuit breaker / contactor

For operation in accordance with the block diagram, the Sepam must have the logic inputs required (an MES114 module must therefore be included) and the related parameter setting and wiring must be done.

Remote tripping

Circuit breaker / contactor tripping may be controlled remotely via the communication link.

The circuit breaker / contactor tripping order may be activated at any time and is not inhibited by logic input I25.

Circuit breaker / contactor closing orders and Sepam acknowledgment via the communication link may be inhibited by logic input I25.

Circuit breaker / contactor control with lockout function (ANSI 86)

The ANSI 86 function traditionally performed by lockout relays may be carried out by Sepam using the predefined Circuit breaker / contactor control function, with latching of all tripping conditions (protection function outputs and logic inputs).

With this function, Sepam performs the following:

■ grouping of all tripping conditions and breaking device control

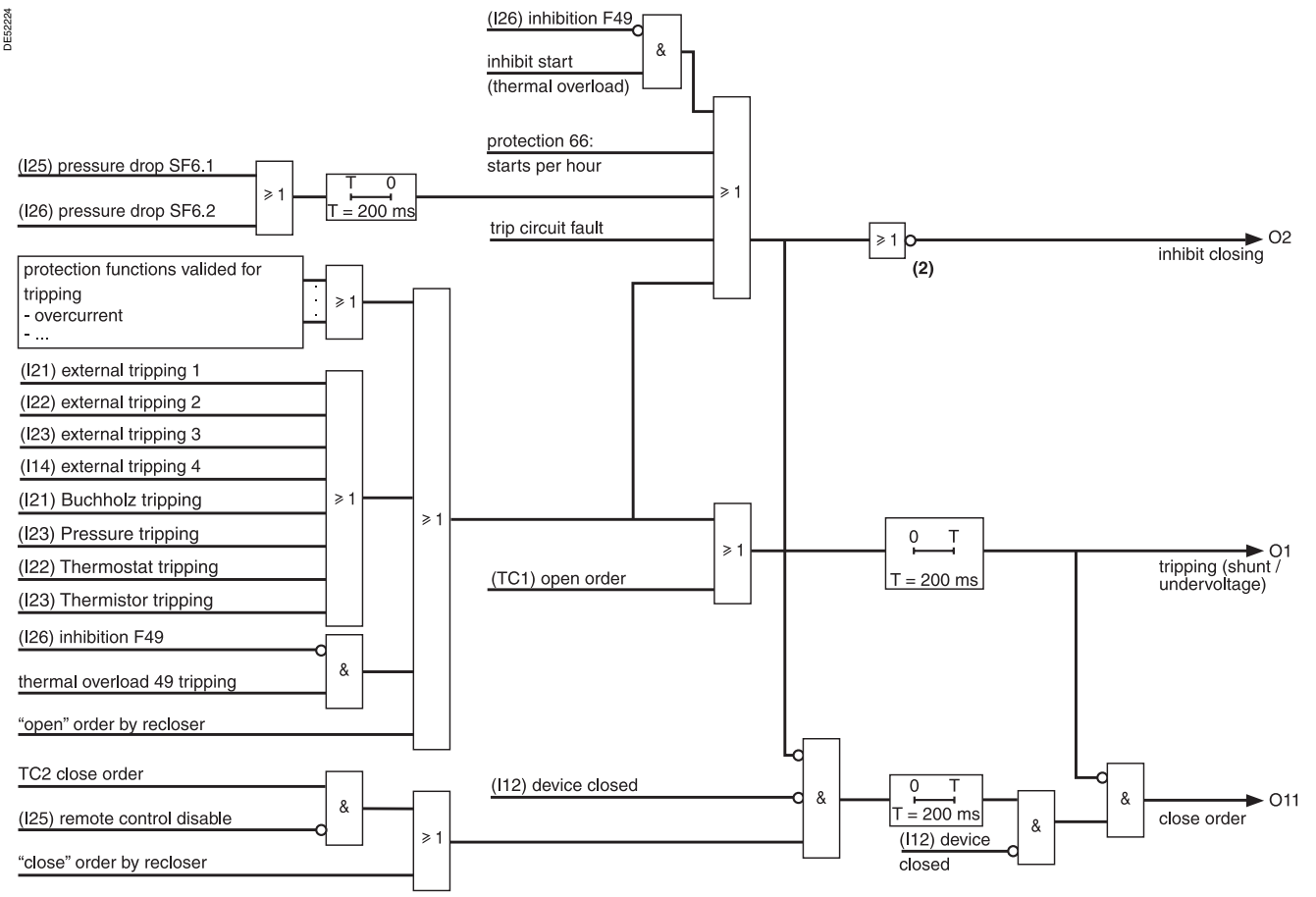
■ latching of the tripping order with inhibition of closing until the cause of tripping disappears and is acknowledged by the user (see "Latching / acknowledgment")

■ indication of the cause of tripping:

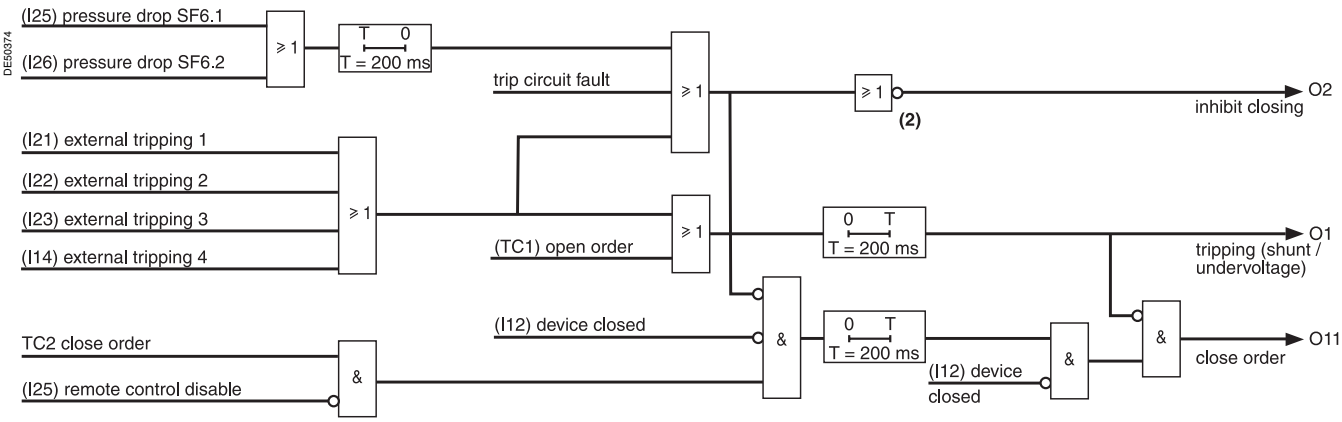
□ locally by signal lamps ("Trip" and others) and by messages on the display

□ remotely by remote indications.

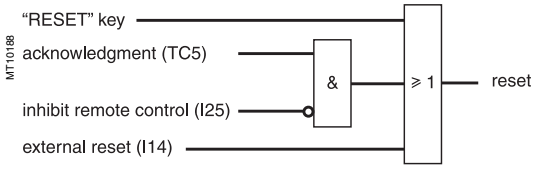
Block diagram (1): Sepam S20, T20 or M20



Block diagram (1): Sepam B21 (3) or B22

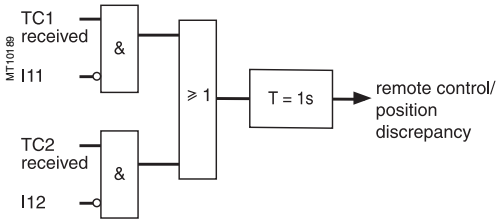


(1) *Data used in the logic block diagram depend on the Sepam type, availability of MES114 option and general parameters.*
(2) *The usual case in which O2 is set to "undervoltage coil" (normaly closed).*
(3) *Performs B20 type functions.*



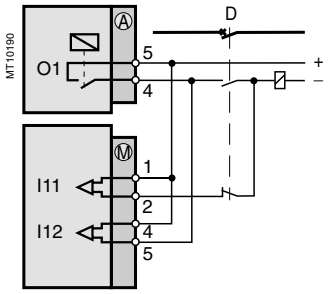
Latching / acknowledgment

The tripping outputs of all the protection functions and all the logic inputs may be latched individually.
Logic outputs may not be latched. The logic outputs set up in pulse mode maintain pulse-type operation, even when linked to latched data.
Latched data are saved in the event of a power failure.
All latched data may be acknowledged locally on the UMI, or remotely by means of a logic input or via the communication link.
The "Latching / acknowledgment" function associated with the "Circuit breaker / contactor control" function may be used to perform the ANSI 86 "lockout relay" function.

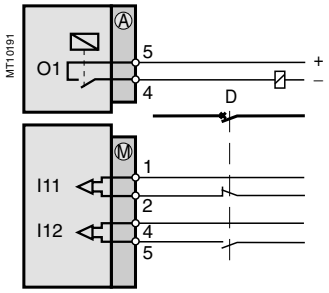


TC/circuit breaker position discrepancy

This function detects a discrepancy between the last remote control order received and the actual position of the circuit breaker.
The information is accessible via remote indication TS42.



Wiring for shunt trip unit.



Wiring for undervoltage trip unit.

Trip circuit supervision and open / closed matching

Description

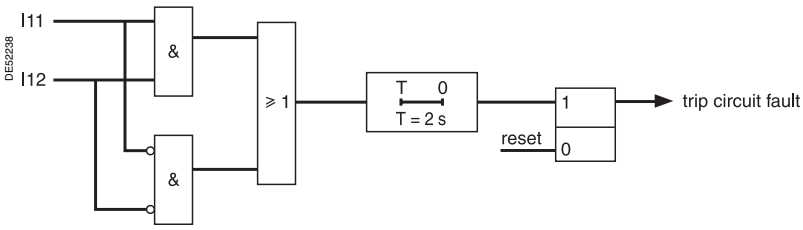
This supervision is designed for trip circuits:
- ■ with shunt trip units

The function detects:
- □ circuit continuity
- □ loss of supply
- □ mismatching of position contacts.

The function inhibits closing of the breaking device.
- ■ with undervoltage trip units

The function detects mismatching of position contacts, coil supervision being unnecessary in this case.
The information is accessible in the matrix and via the remote indication TS43.

Block diagram (1)



***(1)** With MES option.*
The function is activated if inputs I11 and I12 are set respectively as circuit breaker "open position" and circuit breaker "closed position".

Open and close order supervision

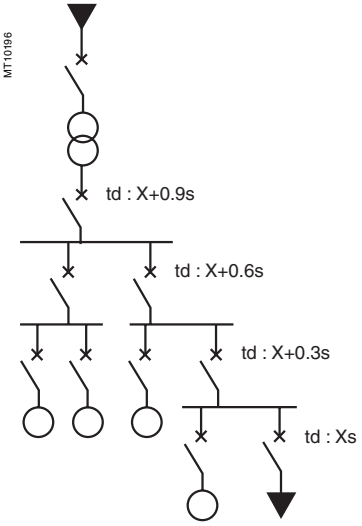
Following a circuit breaker open or close order, the system checks whether, after a 2 seconds time delay, the circuit breaker has actually changed status.
If the circuit breaker status does not match the last order sent, a "Control fault" message and remote indication TS45 are generated.

Logic discrimination
ANSI code 68

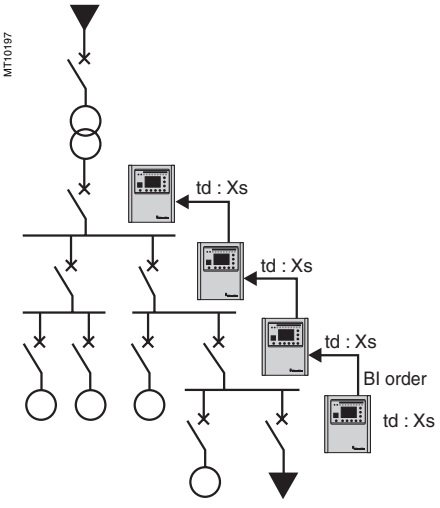
Description

This function provides:
- full tripping discrimination
- a substantial reduction in delayed tripping of the circuit breakers located nearest the source (drawback of the classical time-based discrimination process).

The system applies to the definite time (DT) and IDMT phase overcurrent and earth fault protection functions.



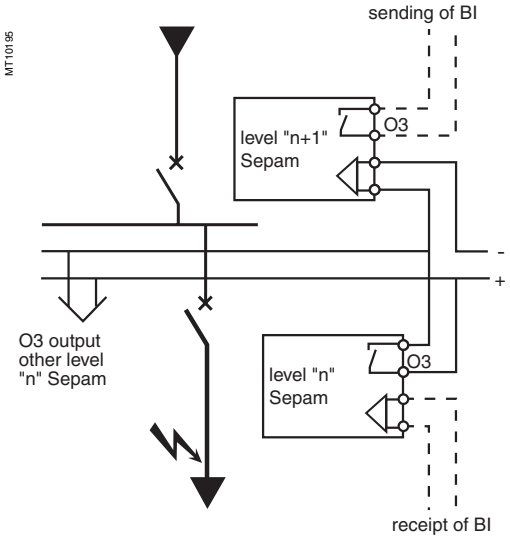
e.g.: Radial distribution with use of time-based discrimination (td: tripping time definite time curves).



e.g.: radial distribution with use of the Sepam logic discrimination system.

With this type of system, time delays are set in accordance with the device to be protected, without any concern for the discrimination aspect.

Operating principle



When a fault occurs in a radial network, the fault current flows through the circuit between the source and the location of the fault:
- the protection units upstream from the fault are triggered
- the protection units downstream from the fault are not triggered
- only the first protection unit upstream from the fault should trip.

Each Sepam is capable of sending and receiving blocking input orders except for motor Sepams **(1)** which can only send blocking input orders.

When a Sepam is triggered by a fault current:
- it sends a blocking input order to output O3 **(2)**
- it trips the associated circuit breaker if it does not receive a blocking input order on the blocking input logic input **(3)**.

The sending of the blocking input lasts the time it takes to clear the fault.

It is interrupted after a time delay that takes into account the breaking device operating time and protection unit reset time.

This system minimizes the duration of the fault, optimizes discrimination and guarantees safety in downgraded situations (wiring or switchgear failure).

Pilote wire test

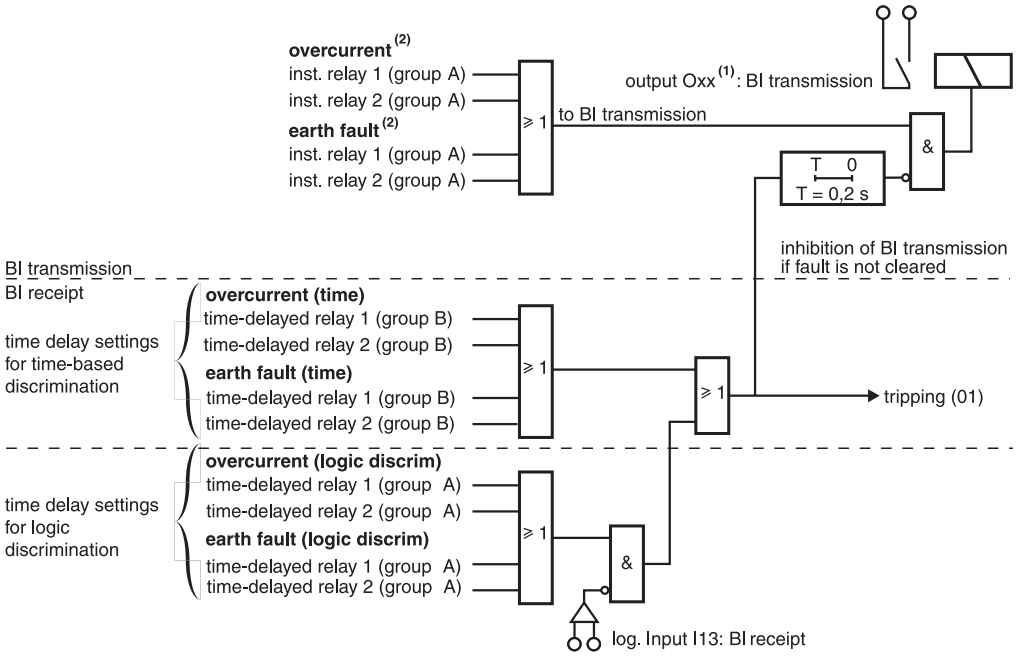
The pilot wire test may be performed using the output relay test function.

(1) *Motor Sepams are not affected by the receipt of a blocking input since they are designed for loads only.*
(2) *Default parameter setting.*
(3) *According to parameter setting and presence of an additional MES114 module.*

Logic discrimination
ANSI code 68

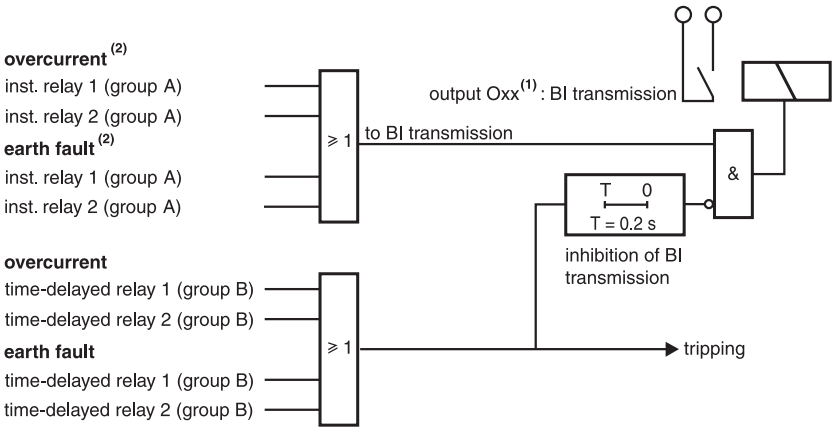
Block diagram: Sepam S20 and T20

DE50375



Block diagram: Sepam M20

DE50376



(1) *According to parameter setting (O3 by default).*
(2) *Instantaneous action (inst) corresponds to protection "pick-up" signal information.*

Disturbance recording triggering Switching of groups of settings

Disturbance recording trigger

Description

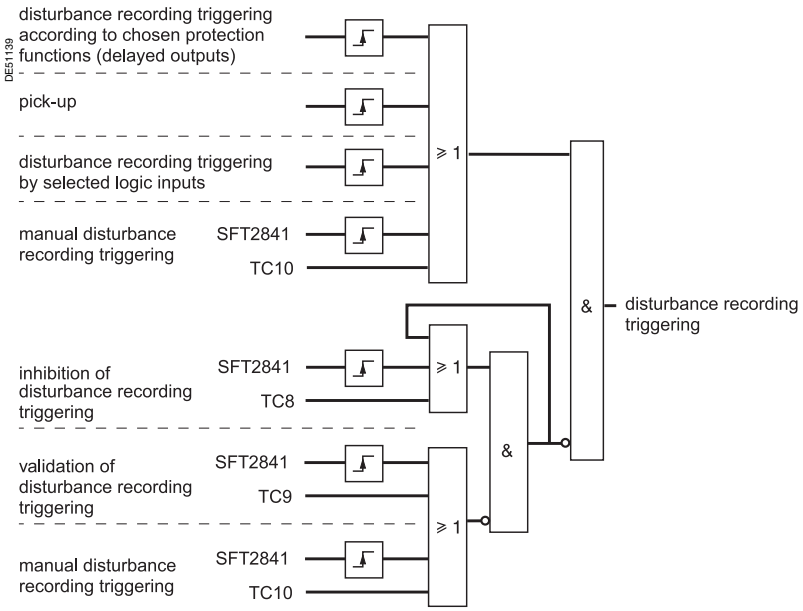
The recording of analog and logic signals may be triggered by different events, according to control matrix parameter setting or by manual action:

- triggering by the grouping of all pick-up signals of the protection functions in service
- triggering by the delayed outputs of selected protection functions
- triggering by selected logic inputs
- manual triggering by a remote control order (TC10)
- manual triggering via the SFT2841 software tool.

Disturbance recording may be:

- inhibited via the SFT2841 software or by remote control order (TC8)
- validated via the SFT2841 software or by remote control order (TC9).

Block diagram



Switching of groups of settings

There are 4 relays for the phase overcurrent and earth fault protection functions, split into two groups of 2 relays, called group A and group B respectively.
The use of the protection relays is determined by parameter setting.
The switching of groups of settings function enables the group A or group B protection functions to be activated:

- according to the status of logic input I13
  - I13 = 0: activation of group A
  - I13 = 1: activation of group B
- or via the communication link
  - TC3: activation of group A
  - TC4: activation of group B.

The use of the switching of groups of settings functions does not exclude the use of the logic discrimination function.

Indications
ANSI code 30

Events may be indicated on the front panel of Sepam by:
- appearance of a message on the display of the advanced UMI
- lighting up of one of the 9 yellow signal lamps.

Message type indication

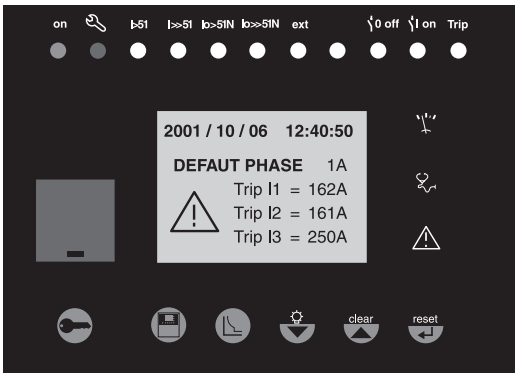
Predefined messages
All the messages connected to the standard Sepam functions are predefined and available in two language versions:
- in English, factory messages, not modifiable
- in the local language, according to the version delivered.

The language version is chosen at the time of Sepam parameter setting.
The messages are visible on the display units of Sepams equipped with the advanced UMI and in the SFT2841 Alarms screen.
- the number and type of predefined messages depend on type of Sepam. The table below gives the complete list of all predefined messages.

List of messages (1)

Functions	**English** (factory)	**French**
Phase overcurrent	PHASE FAULT	DEFAUT PHASE
Earth fault	EARTH FAULT	DEFAUT TERRE
Thermal overload	THERMAL ALARM	ECHAUF^{T}. ALARME
	THERMAL TRIP	ECHAUF^{T}. DECL^{T}.
Negative sequence / unbalance	UNBALANCE	DESEQUILIBRE
Locked rotor /	ROTOR BLOCKING	BLOCAGE ROTOR
Locked rotor on start	ST^{RT} LOCKED ROT^{R}.	BLOC ROTOR DEM
Excessive starting time	LONG START	DEMARRAGE LONG
Starts per hour	START INHIBIT	DEMARRAGE INHIBE
Phase undercurrent	UNDER CURRENT	COURANT <<
Phase-to-phase overvoltage	OVERVOLTAGE	TENSION >>
Phase-to-phase undervoltage	UNDERVOLTAGE	TENSION <<
Positive sequence undervoltage	UNDERVOLTAGE	TENSION <<
Phase-to-neutral undervoltage	UNDERVOLT. V1	TENSION << V1
	UNDERVOLT. V2	TENSION << V2
	UNDERVOLT. V3	TENSION << V3
Neutral voltage displacement	Vo FAULT	DEFAUT Vo
Overfrequency	OVER FREQ.	FREQUENCE >>
Underfrequency	UNDER FREQ.	FREQUENCE <<
Rate of change of frequency	ROCOF	DERIV. FREQ.
Temperature monitoring (2)	OVER TEMP. ALM	T° ALARME
	OVER TEMP. TRIP	T°. DECL^{T}.
	RTD'S FAULT	DEFAUT SONDES
Thermostat (3)	THERMOS^{T}. ALARM	THERM^{OT}. ALARME
	THERMOS^{T}. TRIP	THERMOS^{T}. DECL^{T}.
Buchholz (3)	BUCHHOLZ ALARM	BUCHH ALARME
	BUCHH/GAS TRIP	BUCHH/GAZ DECL^{T}.
Pressure (3)	PRESSURE TRIP	PRESSION DECL^{T}.
Thermistor PTC/NTC	THERMIS^{T}. ALARM	THERM^{IST}. ALARME
	THERMIS^{T}. TRIP	THERMIS^{T}. DECL^{T}.
Trip circuit supervision	TRIP CIRCUIT	CIRCUIT DECL^{T}.
Circuit breaker / contactor control	CONTROL FAULT	DEFAUT COM^{DE}.
Recloser	PERMANENT FAULT	DEFAUT PERMAN^{T}.
Recloser	CLEARED FAULT	DEFAUT ELIMINE

(1) *According to type of Sepam and Sepam equipped with advanced UMI, or SFT2841. Messages by default, the wording of the messages may be changed (please consult us).*
(2) *RTD fault message: refer to the maintenance chapter.*
(3) *According to parameter setting of the logic inputs I21 to I24 (T20 type).*



Alarm message on the advanced UMI.

Message processing on the advanced UMI display

When an event occurs, the related message appears on the advanced UMI display.
The user presses the clear key to clear the message and be able to consult all the advanced UMI screens in the normal fashion.
The user must press the reset key to acknowledge latched events (e.g. protection outputs).
The list of messages remains accessible in the alarm history (⚠ key), in which the last 64 messages are stored.
To delete the messages stored in the alarm history:
- display the alarm history on the advanced UMI
- press the clear key.

Signal lamp type indication

The 9 yellow signal lamps on the front of Sepam are assigned by default to the following events:

Signal lamp	Event	Label on front panel
LED 1	Tripping of protection 50/51 unit 1	I>51
LED 2	Tripping of protection 50/51 unit 2	I>>51
LED 3	Tripping of protection 50N/51N unit 1	Io>51N
LED 4	Tripping of protection 50N/51N unit 2	Io>>51N
LED 5		Ext
LED 6		
LED 7	Circuit breaker open (I11) (1)	0 off
LED 8	Circuit breaker closed (I12) (1)	I on
LED 9	Tripping by circuit breaker control	Trip

(1) *Assignment by default with MES114.*

The default parameter setting may be personalized using the SFT2841 software:
- the assignment of signal lamps to events is to be defined in the control matrix screen
- editing and printing of personalized labels are proposed in the "Sepam" menu.

Control matrix

PE50610

SFT2841: control matrix.

The control matrix is used for simple assignment of the logic outputs and signal lamps to information produced by the protection units, program logic and logic inputs. Each column creates a logic OR between all the lines selected.
The following data are managed in the control matrix and may be set using the SFT2841 software tool.

Data	Meaning	Comments
All of the application protection functions	Protection time-delayed output and additional outputs when applicable	
79 - cleared fault	The recloser function has sucessfully reclosed	Impulse type output
79 - permanent fault	The circuit breaker is definitively open after the reclosing cycles	Impulse type output
Logic inputs I11 to I14 and I21 to I26	According to configuration	If MES114 module is configured
BI transmission	Sending of the blocking information to the following Sepam in logic discrimination chain	O3 by default
TCS	Trip circuit fault or mismatching of CB position contacts	If the circuit breaker / contactor control function is activated
CB control fault	A circuit breaker open or close order has not been executed	
Sensor fault	Hardware problem on an MET module or on an RTD	
Pick-up	Logical OR of the instantaneous output of all protection units	
Watchdog	Monitoring of Sepam operation	Always on O4 if used

Presentation

Presentation	**5/2**
Modbus protocol	**5/3**
Configuring the communication interfaces	**5/4**
Commissioning and diagnosis	**5/6**
Data addresses and encoding	**5/8**
Time-tagging of events	**5/17**
Access to remote settings	**5/22**
Disturbance recording	**5/31**
Reading Sepam identification	**5/33**

Presentation

General

Modbus communication allows Sepam to be connected to a supervisor or any other device with a master Modbus communication channel.
Sepam is always a slave station.

Sepam is connected to a Modbus communication network via a communication interface.
There is a choice of two types of communication interface:
- communication interfaces to connect Sepam to a single network:
  - ACE949-2, for connection to a 2-wire RS 485 network
  - ACE959, for connection to a 4-wire RS 485 network
  - ACE937, for connection to a fiber-optic star network.
- communication interfaces to connect Sepam to two networks:
  - ACE969TP, for connection to:
    - one 2-wire RS 485 Modbus S-LAN supervision communication network
    - one 2-wire RS 485 E-LAN engineering communication network.
  - ACE969FO, for connection to:
    - one fiber-optic Modbus S-LAN supervision communication network
    - one 2-wire RS 485 E-LAN engineering communication network.

Data available

The data available depend on the type of Sepam.

Measurement readout
- phase and earth fault currents
- peak demand phase currents
- tripping currents
- cumulative breaking current
- phase-to-phase, phase-to-neutral and residual voltages
- frequency
- temperatures
- thermal capacity used
- starts per hour and inhibit time
- running hours counter
- motor starting current and time
- operating time before overload tripping
- waiting time after tripping
- operating time and number of operations
- circuit breaker charging time.

Program logic data readout
- a table of 64 pre-assigned remote indications (TS) (depends on the type of Sepam) enables the readout of program logic data status
- readout of the status of 10 logic inputs.

Remote control orders
Writing of 16 impulse-type remote control orders (TC) in either direct mode or SBO (Select Before Operate) mode via 16 selection bits.

Other functions
- reading of Sepam configuration and identification
- time-tagging of events (synchronization via the network or externally via logic input I21), time-tagging within a millisecond
- remote reading of Sepam settings
- remote setting of protection units
- remote control of the analog output (with MSA141 option)
- transfer of disturbance recording data.

(1) *Modbus is a Modicon registered trademark.*

Characterization of exchanges

The Modbus protocol may be used to read or write one or more bits, one or more words, the contents of the event counters or the contents of the diagnosis counters.

Modbus functions supported

The Modbus protocol used by Sepam is a compatible sub-group of the RTU Modbus protocol.
The functions listed below are handled by Sepam:

- basic functions (data access):
  - function 1: reading of n output or internal bits
  - function 2: reading of n input bits
  - function 3: reading of n output or internal words
  - function 4: reading of n input words
  - function 5: writing of 1 bit
  - function 6: writing of 1 word
  - function 7: high-speed reading of 8 bits
  - function 8: reading of diagnosis counters
  - function 11: reading of Modbus event counters
  - function 15: writing of n bits
  - function 16: writing of n words.
- communication-management functions:
  - function 8: Modbus diagnosis
  - function 11: reading of Modbus event counter
  - function 43: sub-function 14: reading of identification.

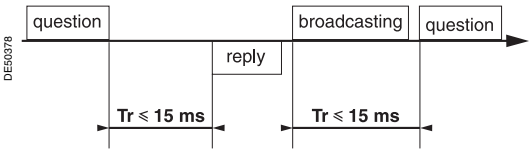
The following exception codes are supported:

- 1: unknown function code
- 2: incorrect address
- 3: incorrect data
- 4: not ready (cannot process request)
- 7: not acknowledged (remote reading and setting).

Response time

The communication coupler **response time (Tr)** is less than 15 ms, including a
3-character silence (approximately 3 ms at 9600 bauds).
This time is given with the following parameters:

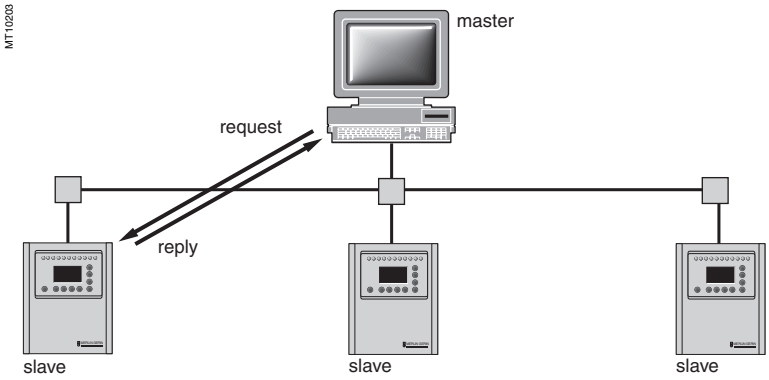
- 9600 bauds
- format: 8 bits, odd parity, 1 stop bit.



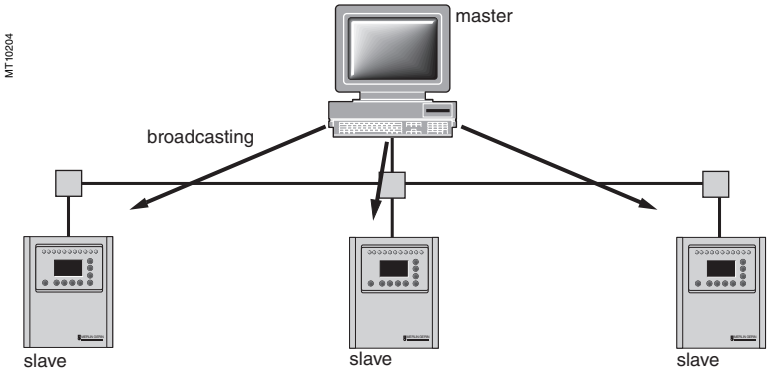
Synchronization of exchanges

Any character that is received after a silence of more than 3 characters is considered as the beginning of a frame. A silence of at least 3 characters must be left on the line between two frames.
Example: at 9600 bauds, this time is equal to approximately 3 milliseconds.

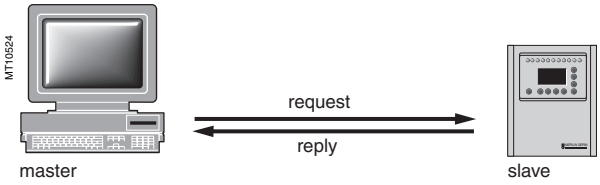
Protocol principle



Exchanges are initiated by the master and include a request by the master and a reply by the slave (Sepam). Requests by the master are either addressed to a given Sepam identified by its number in the first byte of the request frame, or addressed to all the Sepam (broadcasting).



Broadcast commands are necessarily write commands.
No replies are transmitted by the Sepam.



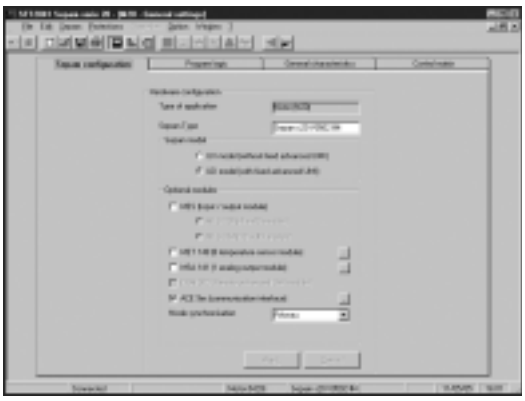
It is not necessary to have a detailed knowledge of the protocol unless the master is a central computer which requires the corresponding programming. All Modbus exchanges include 2 messages: a request by the master and a reply by the Sepam. All the frames that are exchanged have the same structure. Each message or frame contains 4 types of data:

slave number	function code	data zones	CRC 16 check zone

- slave number (1 byte): this indicates the receiving Sepam (0 to FFh).
If it is equal to zero, the request concerns all the slaves (broadcasting) and there is no reply message
- function code (1 byte): this is used to select a command (read, write, bit, word) and to check that the reply is correct
- data zones (n bytes): these zones contain the parameters relating to the function: bit, address, word address, bit value, word value, number of bits, number of words
- check zone (2 bytes): this zone is used to detect transmission errors.

Configuring the communication interfaces

PE50583



SFT2841: Sepam Configuration screen.

Access to configuration parameters

The Sepam communication interfaces are configured using SFT2841 software. The configuration parameters can be accessed from the Communication configuration window in SFT2841.
To access this window:

- open the **Sepam configuration** window in SFT2841
- check the box for ACE9xx (communication interface)
- click [...]: the **Communication configuration** window appears
- select the type of interface used: ACE949/ACE959/ACE937, ACE969TP or ACE969FO
- select the Modbus communication protocol.

The configuration parameters will vary depending on the communication interface selected: ACE949/ACE959/ACE937, ACE969TP or ACE969FO. The table below specifies the parameters to be configured depending on the communication interface chosen.

Parameters to be configured	ACE949 ACE959 ACE937	ACE969TP	ACE969FO
Physical layer parameters	■	■	■
Fiber-optic parameters			■
Modbus advanced parameters	■	■	■
E-LAN parameters		■	■

PE50584

SFT2841: communication configuration window for ACE949.

Configuring the physical layer of the Modbus port

Asynchronous serial transmission is used with the following character format:

- 8 data bits
- 1 stop bit
- parity according to parameter setting.

The configuration parameters for the physical layer of the Modbus port are:

- slave number (Sepam address)
- transmission speed
- parity check type.

Parameters	Authorized values	Default value
Sepam address	1 to 247	1
Speed	4800, 9600, 19200 or 38400 bauds	19200 bauds
Parity	None, Even or Odd	Even

Configuring the ACE969FO fiber-optic port

The configuration for the physical layer of the ACE969FO fiber-optic port is completed with the following 2 parameters:

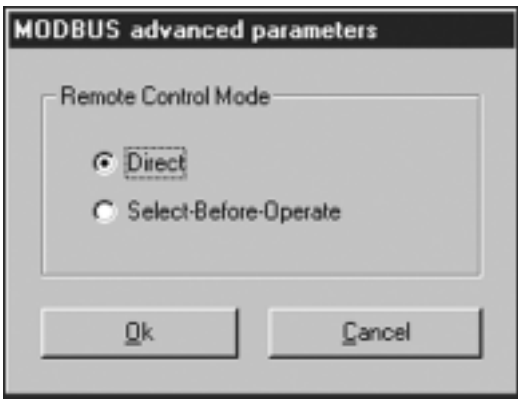
- link idle state: light-on or light-off
- echo mode: with or without.

Fiber-optic parameters	Authorized values	Default value
Link idle state	Light Off or Light On	Light Off
Echo mode	Yes (fiber-optic ring) or No (fiber-optic star)	No

Note: *in echo mode, the Modbus master will receive the echo of its own request before the slave's reply. The Modbus master must be able to disregard this echo. Otherwise, it is impossible to create a Modbus fiber-optic ring.*

Configuring the communication interfaces

PE50585



SFT2841: Modbus advanced parameters window.

Configuring Modbus advanced parameters

The Sepam remote control mode is selected from the Advanced parameters window.

Advanced parameters	Authorized values	Default value
Remote control mode	Direct or SBO (Select Before Operate) mode	Direct

PE50586

SFT2841: communication configuration window for ACE969FO.

Configuring the physical layer of the ACE969 E-LAN port

The E-LAN port on the ACE969TP and ACE969FO communication interfaces is a 2-wire RS 485 port.

The configuration parameters for the physical layer of the E-LAN port are:

- Sepam address
- transmission speed
- parity check type.

Parameters	Authorized values	Default value
Sepam address	1 to 247	1
Speed	4800, 9600, 19200 or 38400 bauds	38400 bauds
Parity	None, Even or Odd	Odd

Configuration tips

- The Sepam address MUST be assigned before Sepam is connected to the communication network.
- You are also strongly advised to set the other physical layer configuration parameters before making the connection to the communication network.
- Modifying the configuration parameters during normal operation will not disturb Sepam but will reset the communication port.

Installing the communication network

Preliminary study

The communication network must first be the subject of a technical study to determine the following, according to the installation characteristics and constraints (geography, amount of information processed, etc.):

- the type of medium (electrical or fiber optic)
- the number of Sepam units per network
- the transmission speed
- the ACE interfaces configuration
- the Sepam parameter settings.

Sepam user manual

The communication interfaces must be installed and connected in accordance with the instructions in the Installation chapter of this manual.

Preliminary checks

The following preliminary checks must be made:

- check the CCA612 cord connection between the ACE interface and the Sepam base unit
- check the ACE Modbus communication port connection
- check the complete configuration of the ACE
- for the ACE969, check the auxiliary power supply connection.

Checking the operation of the ACE interface

You can use the following to check that an ACE interface is operating correctly:

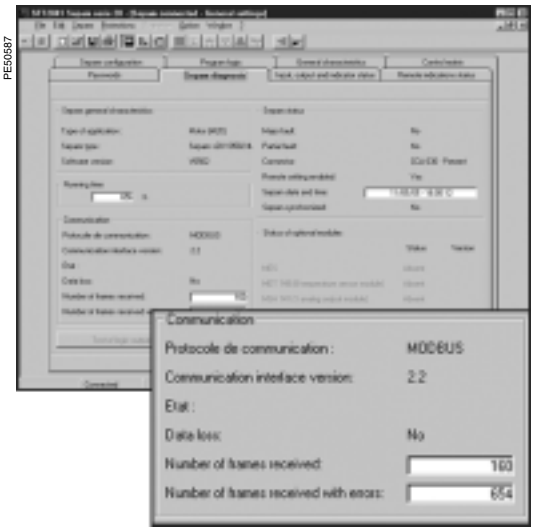
- the indicator LEDs on the front panel of the ACE
- the information provided by the SFT2841 software connected to Sepam:
  - on the Diagnosis screen
  - on the Communication configuration screens.

Link activity LED for ACE949-2, ACE959 and ACE937

The link activity LED for ACE949-2, ACE959 and ACE937 interfaces flashes when Sepam transmission or reception is active.

Indicator LEDs on the ACE969

- green "on" LED: ACE969 energized
- red "key" LED: ACE969 interface status
  - LED off: ACE969 configured and communication operational
  - LED flashing: ACE969 configuration error or ACE969 not configured
  - LED on: ACE969 error
- link activity LED: S-LAN Tx flashing, Sepam transmission active
- link activity LED: S-LAN Rx flashing, Sepam reception active.



SFT2841: Sepam series 20 diagnosis screen.

Diagnosis using SFT2841 software

Sepam diagnosis screen

When connected to Sepam, the SFT2841 software informs the operator of the general Sepam status and of the Sepam communication status in particular.
All Sepam status information appears on the Sepam diagnosis screen.

Sepam communication diagnosis

The operator is provided with the following information to assist with identifying and resolving communication problems:

- name of the protocol configured
- Modbus interface version number
- number of valid frames received (CPT9)
- number of invalid (mistaken) frames received (CPT2).

Link activity LED

The ACE interface link activity LEDs are activated by variations in the signal on the Modbus network. When the supervisor communicates with Sepam (during transmission or reception), these LEDs flash.
After wiring, check the information given by the link activity LEDs when the supervisor operates.

Note: *Flashing indicates that there is traffic passing to or from Sepam; it does not mean that the exchanges are valid.*

Functional test

If there is any doubt about correct operation of the link:
- run read/write cycles in the test zone
- use Modbus diagnosis function 8 (sub-code 0, echo mode).

The Modbus frames below, transmitted or received by a supervisor, are an example of a test performed when communication is set up.

Test zone	
Read	
Transmission	01 03 0C00 0002 C75B
Reception	01 03 04 0000 0000 FA33
Write	
Transmission	01 10 0C00 0001 02 1234 6727
Reception	01 10 0C00 0001 0299
Read	
Transmission	01 03 0C00 0001 875A
Reception	01 03 02 1234 B533
Function 8 - Modbus diagnosis, echo mode	
Transmission	01 08 0000 1234 ED7C
Reception	01 08 0000 1234 ED7C

Even in echo mode, Sepam recalculates and checks the CRC sent by the master:
- If the CRC received is valid, Sepam replies
- If the CRC received is invalid, Sepam does not reply.

Modbus diagnosis counters

Counter definition

Sepam manages the Modbus diagnosis counters. These are:
- **CPT1**: Number of valid frames received, whether the slave is involved or not
- **CPT2**: Number of frames received with a CRC error or physical error (frames with more than 255 bytes, frames received with at least one parity, overrun, framing or line-break error)
- **CPT3**: Number of exception responses generated (even if not transmitted, due to receipt of a broadcast request)
- **CPT4**: Number of frames specifically addressed to the station (excluding broadcasting)
- **CPT5**: Number of valid broadcast frames received
- **CPT6**: Not significant
- **CPT7**: Not significant
- **CPT8**: Number of frames received with at least one character having a physical error (parity, overrun, framing or line break)
- **CPT9**: Number of valid requests received and correctly executed.

Counter reset

The counters are reset to 0:
- when they reach the maximum value FFFFh (65535)
- when they are reset by a Modbus command (function 8)
- when Sepam auxiliary power is lost
- when communication parameters are modified.

Using the counters

Modbus diagnosis counters help to detect and resolve communication problems. They can be accessed by the dedicated read functions (Modbus protocol functions 8 and 11).
CPT2 and CPT9 counters can be displayed on SFT2841 ("Sepam Diagnosis" screen).
An incorrect speed (or parity) increments CPT2.
Non-reception is signaled by the lack of change on CPT9.

Operating anomalies

It is advisable to connect the Sepam units to the Modbus network one by one. Make sure that the supervisor is sending frames to the relevant Sepam by checking the activity on the RS 232 - RS 485 converter or the fiber-optic converter if there is one, and on the ACE module.

RS 485 network
- check the wiring on each ACE module
- check the tightness of the screw terminals on each ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam base unit
- check that polarization is only at one point and that impedance matching is at both ends of the RS 485 network
- check the auxiliary power supply connection to the ACE969TP
- check that the ACE909-2 or ACE919 converter used is connected, powered and set up correctly.

Fiber-optic network
- check the connections on the ACE module
- check the connection of the CCA612 cord linking the ACE module to the Sepam base unit
- check the auxiliary power supply connection to the ACE969FO
- check that the converter or fiber-optic star used is connected, powered and set up correctly
- for a fiber-optic ring, check that the Modbus master can handle the echo of its requests correctly.

In all cases
- check all the ACE configuration parameters on SFT2841
- check the CPT2 and CPT9 diagnostic counters on the SFT2841 ("Sepam Diagnosis" screen).

Data addresses and encoding

Presentation

Data which are similar from the monitoring and control application viewpoint are grouped together in adjacent address zones:

	Hexadecimal starting address	Ending address	Modbus functions enabled
Synchronization zone	0002	0005	3, 16
Identification zone	0006	000F	3
First event table			
Exchange word	0040	0040	3, 6, 16
Events (1 to 4)	0041	0060	3
Second event table			
Exchange word	0070	0070	3, 6, 16
Events (1 to 4)	0071	0090	3
Data			
States	0100	0105	3, 4 1, 2*
Measurements	0106	0131	3, 4
Remote control orders	01F0	01F0	3, 4, 6, 16 1, 2, 5, 15*
Remote control confirmation	01F1	01F1	3, 4, 6, 16 1, 2, 5, 15*
Test zone	0C00	0C0F	3, 4, 6, 16 1, 2, 5, 15
Protection settings			
Reading	2000	207C	3
Reading request	2080	2080	3, 6, 16
Remote settings	2100	217C	3, 6
Disturbance recording			
Choice of transfer function	2200	2203	3, 16
Identification zone	2204	2228	3
Fault rec. exchange word	2300	2300	3, 6, 16
Fault rec. data	2301	237C	3
Application			
Configuration	FC00	FC02	3
Application identification	FC10	FC22	3

N.B. Non-addressable zones may reply by an exception message or else supply non-significant data.
(*) these zones may be accessed in word mode or in bit mode.
The address of bit i ($0 \leqslant i \leqslant F$) of address word J is then (J x 16) + i.
e.g. 0C00 bit 0 = C000 0C00 bit 7 = C007.

Synchronization zone

The synchronization zone is a table which contains the absolute date and time for the time-tagging function. Time messages should be written in a single block containing 4 words, using function 16: write word.
Messages can be read word by word or by groups of words using function 3.

Synchronization zone	Word address	Access	Modbus function enabled
Binary time (year)	0002	Read/write	3, 16
Binary time (months + days)	0003	Read	3
Binary time (hours + minutes)	0004	Read	3
Binary time (milliseconds)	0005	Read	3

See "time-tagging of events" chapter for data format.

Identification zone

The identification zone contains system-type information pertaining to the identification of the Sepam equipment.
Some of the information in the identification zone is also found in the configuration zone at the address FC00h.

Identification zone	Word address	Access	Modbus function enabled	Format	Value
Manufacturer identification	0006	R	3		0100
Equipment	0007	R	3		0
Marking + equipment type	0008	R	3		Idem FC01
Modbus version	0009	R	3		Idem FC02
Application version	000A/B	R	3	Not managed	0
Sepam check-word	000C	R	3		Idem 0100
Synthesis zone	000D	R	3	Not managed	0
Command	000E	R/W	3/16	Not managed	Init. to 0
Extension address	000F	R	3		FC00

This zone is provided to ensure compatibility with existing equipment. A more complete description is available starting at address FC00h in the configuration zone or using the identification read function.

First events zone

The events zone is a table which contains a maximum of 4 time-tagged events.
Events should be read in a single block containing 33 words using function 3.
The exchange word can be written using functions 6 or 16, and read individually using function 3.

Events zone 1	Word address	Access	Modbus function enabled
Exchange word	0040	Read/write	3, 6, 16
Event n°1	0041-0048	Read	3
Event n°2	0049-0050	Read	3
Event n°3	0051-0058	Read	3
Event n°4	0059-0060	Read	3

See "time-tagging of events" chapter for data format.

Second events zone

The events zone is a table which contains a maximum of 4 time-tagged events.
Events should be read in a single block containing 33 words using function 3.
The exchange word can be written using functions 6 or 16 and read individually using function 3.

Events zone 2	Word address	Access	Modbus function enabled
Exchange word	0070	Read/write	3, 6, 16
Event n°1	0071-0078	Read	3
Event n°2	0079-0080	Read	3
Event n°3	0081-0088	Read	3
Event n°4	0089-0090	Read	3

See "time-tagging of events" chapter for data format.

Status zone

The **status zone** is a table which contains the Sepam check-word, pre-assigned remote annunciation bits (TS), and logic inputs.

Status	Word address	Bit address	Access	Modbus function enabled	Format
Sepam check-word	100	1000	R	3/4 or 1, 2, 7	X
TS1-TS16	101	1010	R	3/4 or 1, 2	B
TS17-TS32	102	1020	R	3/4 or 1, 2	B
TS33-TS48	103	1030	R	3/4 or 1, 2	B
TS49-TS64	104	1040	R	3/4 or 1, 2	B
Logic inputs	105	1050	R	3/4 or 1, 2	B

Measurement zone (S20, T20, M20 types)

Measurements	Word address	Access	Modbus function enabled	Format	Unit
I1 phase current (gain x 1)	106	R	3/4	16NS	0.1 A
I2 phase current (gain x 1)	107	R	3/4	16NS	0.1 A
I3 phase current (gain x 1)	108	R	3/4	16NS	0.1 A
I0 residual current (gain x 1)	109	R	3/4	16NS	0.1 A
Im1 average phase current (x 1)	10A	R	3/4	16NS	0.1 A
Im2 average phase current (x 1)	10B	R	3/4	16NS	0.1 A
Im3 average phase current (x 1)	10C	R	3/4	16NS	0.1 A
I1 phase current (gain x 10)	10D	R	3/4	16NS	1 A
I2 phase current (gain x 10)	10E	R	3/4	16NS	1 A
I3 phase current (gain x 10)	10F	R	3/4	16NS	1 A
I0 residual current (gain x 10)	110F	R	3/4	16NS	1 A
IM1 average phase current (x10)	111	R	3/4	16NS	1 A
IM2 average phase current (x10)	112	R	3/4	16NS	1 A
IM3 average phase current (x10)	113	R	3/4	16NS	1 A
IM1 peak demand phase current	114	R	3/4	16NS	1 A
IM2 peak demand phase current	115	R	3/4	16NS	1 A
IM3 peak demand phase current	116	R	3/4	16NS	1 A
Reserved	117	R	3/4	-	-
Itrip1 tripping current	118	R	3/4	16NS	10 A
Itrip2 tripping current	119	R	3/4	16NS	10 A
Itrip3 tripping current	11A	R	3/4	16NS	10 A
Itrip0 tripping current	11B	R	3/4	16NS	1 A
Cumulative breaking current	11C	R	3/4	16NS	1 $(kA)^2$
Number of operations	11D	R	3/4	16NS	1
Operating time	11E	R	3/4	16NS	1 ms
Charging time	11F	R	3/4	16NS	1 sec
Reserved	120	R	3/4	-	-
Running hours counter	121	R	3/4	16NS	1 hr
Thermal capacity used	122	R	3/4	16NS	%
Operating time before overload tripping	123	R	3/4	16NS	1 min
Waiting time after overload tripping	124	R	3/4	16NS	1 min
Unbalance ratio	125	R	3/4	16NS	% Ib
Starting time / overload	126	R	3/4	16NS	0.1 sec
Starting current overload	127	R	3/4	16NS	1 A
Start inhibit time delay	128	R	3/4	16NS	1 min
Number of starts allowed	129	R	3/4	16NS	1
Temperatures 1 to 8	12A/131	R	3/4	16S	1 °C
Reserved	132/1EF	Prohibited			

Note: *Only the measurements related to the Sepam function are significant. The values of the others are zero.*

Measurement zone (B20, B21, B22 types)

Measurements	Word address	Access	Modbus function enabled	Format	Unit
U21 phase to phase voltage (x1)	106	R	3/4	16NS	1 V
U32 phase to phase voltage (x1)	107	R	3/4	16NS	1 V
U13 phase to phase voltage (x1)	108	R	3/4	16NS	1 V
V1 phase to neutral voltage (x1)	109	R	3/4	16NS	1 V
V2 phase to neutral voltage (x1)	10A	R	3/4	16NS	1 V
V3 phase to neutral voltage (x1)	10B	R	3/4	16NS	1 V
V0 residual voltage (x1)	10C	R	3/4	16NS	1 V
Positive sequence voltage (x1)	10D	R	3/4	16NS	1 V
Frequency	10E	R	3/4	16NS	0.01 Hz
U21 phase to phase voltage (x10)	10F	R	3/4	16NS	1 V
U32 phase to phase voltage (x10)	110	R	3/4	16NS	1 V
U13 phase to phase voltage (x10)	111	R	3/4	16NS	1 V
V1 phase to neutral voltage (x10)	112	R	3/4	16NS	1 V
V2 phase to neutral voltage (x10)	113	R	3/4	16NS	1 V
V3 phase to neutral voltage (x10)	114	R	3/4	16NS	1 V
V0 residual voltage (x10)	115	R	3/4	16NS	1 V
Positive sequence voltage (x10)	116	R	3/4	16NS	1 V
Reserved	*117/131*	*R*	*3/4*		*init. to 0*
Reserved	*132/1EF*	*Prohibited*			

Accuracy
The accuracy of the measurements depends on the order of the unit: it is equal to the value of the point divided by 2.

Examples		
I1	Unit = 1 A	Accuracy = 1/2 = 0.5 A
U21	Unit = 10 V	Accuracy = 10/2 = 5 V

Remote control zone

The remote control zone is a table which contains the pre-assigned remote control bits (TC). The zone may be read or written using the word functions or bit functions. See section on remote control orders.

Remote control bits	Word address	Bit address	Access	Modbus function enabled	Format
TC1-TC16	01F0	1F00	R/W	3/4/6/16 1/2/5/15	B
STC1-STC16	01F1	1F10	R/W	3/4/6/16 1/2/5/15	B
Analog output control	01F2		R/W	3/4/6/16	16S

Protection setting zone

The protection setting zone is an exchange table which is used to read and set protections.

Protection settings	Word address	Access	Modbus function enabled	
Setting read buffer	2000/207C	R	3	
Setting read request	2080	R/W	3/6/16	-
Remote setting request buffer	2100/217C	R/W	3/16	

See section on protection settings.

Fault recorder zone

The fault recorder zone is an exchange table which is used to read records.

Disturbance recording	Word address	Access	Modbus function enabled
Choice of transfer function	2200/2203	R/W	3/16
Identification zone	2204/2228	R	3
Fault rec. exchange word	2300	R/W	3/6/16
Fault rec. data	2301/237C	R	3

See section on fault recorder.

Test zone

The test zone is a 16-word zone that may be accessed via the communication link by all the functions, in both read and write modes, to facilitate communication testing at the time of commissioning or to test the link.

Test zone	Word address	Bit address	Access	Modbus function enabled	Format	
Test	0C00	C000-C00F	read/write	1, 2, 3, 4, 5, 6, 15, 16	none	init. to 0
	0C0F	C0F0-C0FF	read/write	1, 2, 3, 4, 5, 6, 15, 16	none	init. to 0

Configuration zone

The configuration zone contains information pertaining to the hardware and software configuration of the Sepam.

Configuration zone	Word address	Access	Modbus function enabled	Format	
Modbus address (slave no.)	FC00	R	3		
Sepam type (MSB) / hardware config. (LSB)	FC01	R	3	(1)	
Coupler type (MSB)/ version (LSB)	FC02	R	3	(2)	
application identification					
Type of application (S20, M20, etc.)	FC10/15	R	3	ASCII	12 characters
application version	FC16/18	R	3	ASCII	6 characters
application marking	FC19/22	R	3	ASCII	20 characters

(1) *FC01 word:MSB = 10h (Sepam)*
LSB = hardware configuration

(2) *FC02 word:MSB = 01h (Sepam)*
LSB = XY (communicationversion X,Y)

Bit	7	6	5	4	3	2	1	0
Option	**UD/UX**	**reserved**	**MES114E/ MES114F**	**DSM303**	**MSA141**	**MET148-2 (3)**	**MES114**	**MES108**
UX model	0	0	z	x	x	x	y	y
UX model	1	0	z	0	x	x	y	y

(3) *or MET148.*
x = 1 if option included
y = 1 if option included, exlusive options
z = 1 if Vac set up.

Data encoding

For all formats

If a measurement overruns the maximum permissible value for the related format, the value read for the measurement will be the maximum permissible value for the format.

Format 16 NS

All information is encoded in a 16-bit word, in absolute value (unsigned), binary format. The zero bit (b0) is the least significant bit in the word.

Format 16 S signed measurements (temperatures, …)

The information is encoded in a 16-bit word as a complement of 2.
Example:
- 0001 represents +1
- FFFF represents -1.

Format B: Ix

Rank i bit in the word, with i between 0 and F.

Examples		F	E	D	C	B	A	9	8	7	6	5	4	3	2	1	0
Logic inputs	Word address 0105							26	25	24	23	22	21	14	13	12	11
	Bit address 105x																
TS1 to TS16	Word address 0101	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit address 101x																
TS49 to TS64	Word address 0104	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49
	Bit address 104x																
TC1 to TC16	Word address 01F0	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit address 1F0x																
STC1 to STC16	Word address 01F1	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
	Bit address 1F1x																

Format X: Sepam check-word

This format applies only to the Sepam check-word that may be accessed at the word address 100h. This word contains various items of information relating to:
- Sepam operating mode
- time-tagging of events.

Each data item contained in the Sepam check-word may be accessed bit by bit, from address **1000** for the bit b0 to **100F** for the bit b15.
- bit 15 event present
- bit 14 Sepam in “data loss” status
- bit 13 Sepam not synchronous
- bit 12 Sepam time not correct
- bit 11 reserved
- bit 10 Sepam in local setting mode
- bit 9 major fault in Sepam
- bit 8 partial fault in Sepam
- bit 7 setting group A in service
- bit 6 setting group B in service
- bit 3-0 mapping number (1 to 16).

Other bits reserved (undetermined values).

Status changes of bits 6, 7, 8, 10, 12, 13 and 14 of this word trigger the transmission of a time-tagged event.

Bits 3 to 0 encode a “mapping number” (from 1 to 15) which is used to identify the contents of the Modbus addresses, the assignment of which varies depending on the application.

Use of remote annunciation

Sepam provides the communication link with 64 remote annunciation bits (TS).
The TS are pre-assigned to protection and control functions which depend on the Sepam model.
The TS can be read using the bit or word functions.
Each TS transition is time-tagged and stored in the event stack (see section Time-tagging of events).

Address word 0101: TS1 to TS16 (bit address 1010 to 101F)

TS	Use	S20	T20	M20	B21	B22
1	Protection 50/51 relay 1 group A	■	■	■		
2	Protection 50/51 relay 2 group A	■	■	■		
3	Protection 50/51 relay 1 group B	■	■	■		
4	Protection 50/51 relay 2 group B	■	■	■		
5	Protection 50N/51N relay 1 group A	■	■	■		
6	Protection 50N/51N relay 2 group A	■	■	■		
7	Protection 50N/51N relay 1 group B	■	■	■		
8	Protection 50N/51N relay 2 group B	■	■	■		
9	Protection 49 RMS alarm set point		■	■		
10	Protection 49 RMS trip set point		■	■		
11	Protection 37			■		
12	Protection 46	■	■	■		
13	Protection 48/51LR/14 (locked rotor)			■		
14	Protection 48/51LR/14 (rotor locking on start)			■		
15	Protection 48/51LR/14 (excessive starting time)			■		
16	Protection 66			■		

Address word 0102: TS17 to TS32 (bit address 1020 to 102F)

TS	Use	S20	T20	M20	B21	B22
17	Protection 27D/47 relay 1				■	■
18	Protection 27D/47 relay 2				■	■
19	Protection 27 relay 1				■	■
20	Protection 27 relay 2				■	■
21	Protection 27R				■	■
22	Protection 59 relay 1				■	■
23	Protection 59 relay 2				■	■
24	Protection 59N relay 1				■	■
25	Protection 59N relay 2				■	■
26	Protection 81H				■	■
27	Protection 81L relay 1				■	■
28	Protection 81L relay 2				■	■
29	Protection 27S phase 1				■	■
30	Protection 27S phase 2				■	■
31	Protection 27S phase 3				■	■
32	Protection 81R					■

Address word 0103: TS33 to TS48 (bit address 1030 to 103F)

TS	Use	S20	T20	M20	B21	B22
33	Reserved					
34	Recloser in service	■				
35	Recloser in progress	■				
36	Recloser permanent trip	■				
37	Recloser successful trip	■				
38	Send blocking input	■	■	■		
39	Remote setting inhibited	■	■	■	■	■
40	Remote control inhibited	■	■	■	■	■
41	Sepam not reset after fault	■	■	■	■	■
42	Remote control / position discrepancy	■	■	■	■	■
43	Matching fault or Trip Circuit Supervision	■	■	■	■	■
44	Disturbance recording memorized	■	■	■	■	■
45	Control fault	■	■	■	■	■
46	Disturbance recording inhibited	■	■	■	■	■
47	Thermal protection inhibited		■	■		
48	RTD fault		■	■		

Address word 0104: TS49 to TS64 (bit address 1040 to 104F)

TS	Use	S20	T20	M20	B21	B22
49	Protection 38/49T alarm set point sensor 1		■	■		
50	Protection 38/49T tripping set point sensor 1		■	■		
51	Protection 38/49T alarm set point sensor 2		■	■		
52	Protection 38/49T tripping set point sensor 2		■	■		
53	Protection 38/49T alarm set point sensor 3		■	■		
54	Protection 38/49T tripping set point sensor 3		■	■		
55	Protection 38/49T alarm set point sensor 4		■	■		
56	Protection 38/49T tripping set point sensor 4		■	■		
57	Protection 38/49T alarm set point sensor 5		■	■		
58	Protection 38/49T tripping set point sensor 5		■	■		
59	Protection 38/49T alarm set point sensor 6		■	■		
60	Protection 38/49T tripping set point sensor 6		■	■		
61	Protection 38/49T alarm set point sensor 7		■	■		
62	Protection 38/49T tripping set point sensor 7		■	■		
63	Protection 38/49T alarm set point sensor 8		■	■		
64	Protection 38/49T tripping set point sensor 8		■	■		

Use of remote control orders

Remote control orders are pre-assigned to protection, control and metering functions.
Remote control orders may be carried out in two modes:
- direct mode
- confirmed SBO (select before operate) mode.

All the remote control orders may be inhibited by the logic input I25 on the MES114 module, except for the remote control tripping order TC1 which can still be activated at any time.
Logic input I25 may be set up according to 2 modes:
- inhibited if the input is set to 1 ("POS" prefix)
- inhibited if the input is set to 0 ("NEG" prefix).

The device tripping and closing and recloser enable and disable remote control orders are acknowledged if the “CB control“ function is validated and if the inputs necessary for the logic are present on the MES114 (or MES108) optional module.

Direct remote control order
The remote control order is executed when it is written in the remote control word. The program logic resets it to zero after the remote control order is acknowledged.

Confirmed SBO remote control order (Select Before Operate)
In this mode, remote control orders involve two steps:
- selection by the master of the order to be sent by writing of the bit in the STC word and checking of the selection by rereading the word
- execution of the order to be sent by writing of the bit in the TC word.

The remote control order is executed if the bit in the STC word and the bit in the associated word are set; the program logic resets the bit STC and TC bits to zero after the remote control order is acknowledged.
Deselection of the STC bit takes place:
- if the master deselects it by writing in the STC word
- if the master selects (write bit) a bit other than the one already selected
- if the master sets a bit in the TC word which does not match the selection. In this case, no remote control order is executed.

Address word 01F0: TC1 to TC16 (address bit 1F00 to 1F0F)

TC	Use	S20	T20	M20	B21	B22
1	Tripping	■	■	■	■	■
2	Closing	■	■	■	■	■
3	Swtiching to setting group A	■	■	■		
4	Switching to setting group B	■	■	■		
5	Sepam reset (reset)	■	■	■	■	■
6	Peak demand current zero reset	■	■	■	■	■
7	Inhibit thermal protection		■	■		
8	Inhibit disturbance recording triggering	■	■	■	■	■
9	Confirm disturbance recording triggering	■	■	■	■	■
10	Manual disturbance recording triggering	■	■	■	■	■
11	Enable recloser	■				
12	Disable recloser	■				
13	Confirm thermal protection		■	■		
14	*Reserved*					
15	*Reserved*					
16	*Reserved*					

Analog output remote control

The analog output of the MSA141 module may be set up for remote control via the Modbus communication module (word address 01F2). The working range of the numerical value transmitted is defined by the parameter setting of the "min. value" and "max. value" of the analog output.
This function is not affected by remote control inhibition conditions.

Time-tagging of events

Presentation

The communication system time-tags the data prcessed by Sepam. The time-tagging function assigns a date and precise time to status changes so that they can be accurately classified with over time. Time-tagged data are events that can be processed in the control room by the remote monitoring and control system using the communication protocol for data logging and chronological reports.
Sepam time-tags the following data:
- logic inputs
- remote annunciation bits
- information pertaining to Sepam equipment (see Sepam check-word).

Time-tagging is carried out systematically.
Chronological sorting of the time-tagged events is performed by the remote monitoring and control system.

Time-tagging
Sepam time-tagging uses absolute time (see section on date and time). When an event is detected, it is tagged with the absolute time given by Sepam's internal clock.
All the Sepam internal clocks must be synchronized so as to avoid drifts and all be the same to allow inter-Sepam chronological sorting. Sepam has two mechanisms for managing its internal clock:
- **time-setting:**

for initializing or modifying the absolute time. A special Modbus message, called "time message", is used to time-set each Sepam
- **synchronization:**

to avoid Sepam internal clock drifts and ensure inter-Sepam synchronization.
Internal clocks can be synchronized according to two principles:
- **internal synchronization:**

via the communication network without any additional cabling,
- **external synchronization:**

via a logic input with additional cabling.
At the time of commissioning, the user sets the synchronization mode parameter.

Initialization of the time-tagging function
Each time the communication system is initialized (energizing of Sepam), the events are generated in the following order:
- appearance of "data loss"
- appearance of "incorrect time"
- appearance of "not synchronous"
- disappearance of "data loss".

The function is initialized with the current values of the remote annunciation and logic input status without creating any events related to these data. After the initialization phase, event detection is activated.
It can only be interrupted by saturation of the internal event storage queue or by the presence of a major fault in Sepam.

Date and time

An absolute date and time are generated internally by Sepam, comprising the following information: Year: Month: Day: Hour: minute: millisecond. The date and time format is standardized (ref.: IEC870-5-4).
Sepam's internal clock is not saved; it needs to be time-set via the communication network each time the Sepam is energized.
Sepam series 20's internal clock may be set in two different ways:
- by the remote monitoring and control system, via the Modbus link
- via the SFT2841 software, "general characteristics" screen.

The time that is tagged on events is encoded in 8 bytes as follows:

b15	b14	b13	b12	b11	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00	word
0	0	0	0	0	0	0	0	0	Y	Y	Y	Y	Y	Y	Y	word 1
0	0	0	0	M	M	M	M	0	0	0	D	D	D	D	D	word 2
0	0	0	H	H	H	H	H	0	0	mn	mn	mn	mn	mn	mn	word 3
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	word 4

Y - 1 byte for years: varies from 0 to 99 years.
The remote monitoring and control system must ensure that the year 00 is greater than 99.
M - 1 byte for months: varies from 1 to 12.
D - 1 byte for days: varies from 1 to 31.
H - 1 byte for hours: varies from 0 to 23.
mn - 1 byte for minutes: varies from 0 to 59.
ms - 2 bytes for milliseconds: varies from 0 to 59999.
This information is encoded in binary form. Sepam is time-set via the "write word" function (function 16) at the address 0002 with a mandatory 4-word time message.
The bits set to "0" in the description above correspond to format fields which are not used and not generated by Sepam.
Since these bits can be transmitted to Sepam with random values, Sepam performs the necessary disabling.
Sepam does not check the consistency or validity of the date and time received.

Synchronization clock

A synchronization clock is required for setting the date and time of Sepam.
Schneider Electric has tested the following equipment:
Gorgy Timing, ref. RT 300, equipped with the M540 module.

Reading of events

Sepam provides the master or masters with two event tables. The master reads the event table and acknowledges by writing the exchange word. Sepam updates its event table.

The events sent by Sepam are not sorted chronologically.

Structure of the first event table:
- exchange word 0040h
- event number 1

0041h ... 0048h
- event number 2

0049h ... 0050h
- event number 3

0051h ... 0058h
- event number 4

0059h ... 0060h

Structure of the second event table:
- exchange word 0070h
- event number 1

0071h ... 0078h
- event number 2

0079h ... 0080h
- event number 3

0081h ... 0088h
- event number 4

0089h ... 0090h

The master necessarily reads a block of 33 words starting at the address 0040h/0070h, or one word at the address 0040h/0070h.

Exchange word

The exchange word is used to manage a special protocol to be sure not to lose events following a communication problem. The event table is numbered for this purpose.

The exchange word includes two fields:
- most significant byte = exchange number (8 bits): 0..255.

b15	b14	b13	b12	b11	b10	b09	b08

Exchange number: 0 .. 255

Description of the MS byte of the exchange word.

The exchange number contains a numbering byte which identifies the exchanges. The exchange number is initialized to zero when Sepam is energized. When it reaches its maximum value (FFh), it automatically returns to 0. Sepam numbers the exchanges and the master acknowledges the numbering.

- least significant byte = number of events (8 bits): 0..4

b07	b06	b05	b04	b03	b02	b01	b00

Number of events: 0 .. 4

Description of LS byte of the exchange word.

Sepam indicates the number of significant events in the event table in the least significant byte of the exchange word. Each non-significant event word is initialized to zero.

Event table acknowledgment

To inform Sepam that the block read by the master has been correctly received, the master writes the number of the last exchange made in the “Exchange number” field, and resets the "Number of events" field of the exchange word to zero. After acknowledgment, the 4 events in the event table are initialized to zero and the old, acknowledged events are erased in Sepam.

Until the exchange word written by the master becomes “X,0” (with X = number of the previous exchange that the master wishes to acknowledge), the exchange word in the table remains at “X, number of previous events”.

Sepam only increments the exchange number when new events are present (X+1, number of new events).

If the event table is empty, Sepam performs no processing operations when the master reads the event table or the exchange word.

The data are encoded in binary form.

Clearing an event queue

Writing a value "xxFFh" in the exchange word (any exchange number, event number = FFh) reinitializes the corresponding event queue (all stored events not yet transmitted are deleted).

Sepam in data loss (1) / no data loss (0) status

Sepam has an internal storage queue with a capacity of 64 events. If the queue becomes saturated, a "data loss" event is inserted by Sepam when each event table is read.

The detection of events stops and the most recent events are lost.

Data loss is managed independently for each of the two event tables. When the tables are read at different rates, data loss may occur at different times for each table or even, in some cases, appear only on the slowest channel.

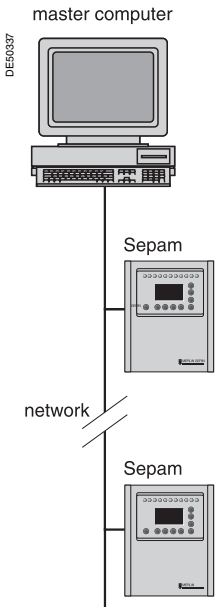
Note: *the "data loss" bit of the Sepam check word corresponds to the status of the first reading table (compatibility with earlier versions).*

Description of event encoding

An event is encoded in 8 words with the following structure:

Most significant byte	Least significant byte	
Word 1: type of event		
08	00	For remote annunciation, internal data, logic inputs
Word 2: event address		
		Refer to bit addresses 1000 to 105F
Word 3: reserved		
00	00	
Word 4: falling edge: disappearance or rising edge: appearance		
00	00	Falling edge
00	01	Rising edge
Word 5: year		
00	0 to 99 (year)	
Word 6: month-day		
1 to 12 (month)	1 to 31 (day)	
Word 7: hours-minutes		
0 to 23 (hours)	0 to 59 (minutes)	
Word 8: milliseconds		
0 to 59999		

Time-tagging of events



Architecture for "internal synchronization" via the communication network.

Synchronization

Sepam accommodates two synchronization modes:

- "internal via the network" synchronization mode by the broadcasting of a "time message" frame via the communication network. Slave number 0 is used for broadcasting
- "external" synchronization mode via a logic input.

The synchronization mode is selected at the time of commissioning via SFT2841.

Internal synchronization via the network mode

The “time message" frame is used for both time-setting and synchronization of Sepam. In this case, it must be sent regularly at brief intervals (between 10 and 60 seconds) in order for synchronous time to be obtained.

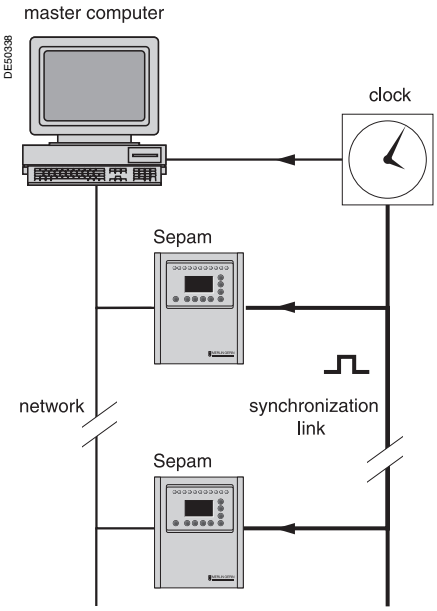
Sepam’s internal clock is reset each time a new time frame is received, and synchronization is maintained if the difference in synchronism is less than 100 milliseconds.

With internal synchronization via the network, accuracy is linked to the master and its mastery of time frame transmission in the communication network.

Sepam is synchronized without delay at the end of the receipt of the frame.

Time changes are made by sending a frame to Sepam with the new date and time. Sepam then switches into a transitional non-synchronous status.

When Sepam is in synchronous status, if no "**time message**” is received for 200 seconds, the appearance of the “not synchronous” event is triggered.



Architecture for "external synchronization" via a logic input.

Synchronization (cont'd)

External synchronization via a logic input mode

Sepam can be synchronized externally by means of a logic input (I21) (the MES114 module is required).

The synchronisation pulse is determined by the rising edge of the logic input.

Sepam can adapt to all synchronization pulse periods from 10 to 60 s, by 10 s steps. The shorter the synchronization period, the more accurate time-tagging of status changes is.

The first time frame is used to initialize Sepam with the absolute date and time (the following frames are used for the detection of any time changes).

The synchronization pulse is used to reset Sepam's internal clock. In the initialization phase, when Sepam is in "non-synchronous" mode, resetting is allowed, within an amplitude of ±4 seconds.

In the initialization phase, the resetting process (switching of Sepam into "synchronous" mode) is based on a measurement of the difference between Sepam's current time and the nearest ten second period. This measurement is taken at the time of the receipt of the synchronization pulse following the initialization time frame. Resetting is allowed if the difference is less than or equal to 4 seconds, in which case Sepam switches to "synchronous" mode.

As of that time (after the switching to "synchronous" mode), the resetting process is based on the measurement of a difference (between Sepam's current time and the nearest ten second period at the time of the receipt of a synchronization pulse), which is adapted to match the synchronization pulse period.

The synchronization pulse period is determined automatically by Sepam when it is energized, based on the first two pulses received: the synchronization pulse must therefore be operational before Sepam is energized.

The synchronization function only operates after Sepam has been time-set, i.e. after the disappearance of the "incorrect time" event.

Any time changes greater than ±4 seconds in amplitude are made by sending a new time frame. The switch from summer time to winter time (and vice versa) is made in this way as well.

There is a temporary loss of synchronism when the time is changed.

The external synchronization mode requires additional equipment, a "synchronization clock " to generate a precise periodic synchronization time pulse.

If Sepam is in "correct time and synchronous" status, and if the difference in synchronism between the nearest ten second period and the receipt of the synchronization pulse is greater than the synchronism error for 2 consecutive synchronization pulses, it switches into non-synchronous status and generates the appearance of a "not synchronous" event.

Likewise, if Sepam is in "correct time and synchronous" status, the failure to receive a synchronization pulse for 200 seconds generates the appearance of a "not synchronous" event.

Access to remote settings

Reading of remote settings (remote reading)

Settings accessible for remote reading
Reading of the settings of all the protection functions may be accessed remotely.

Exchange principle
Remote reading of settings takes place in two steps:
■ first of all, the master indicates the code of the function for which it wishes to know the settings by means of a "request frame". The request is acknowledged, in the Modbus sense of the term, to free the network
■ the master then reads a reply zone to find the required information by means of a "reply frame".
Each function has its own particular reply zone contents. The time needed between the request and the reply is linked to Sepam's low priority cycle time and may vary by several tens to several hundreds of milliseconds.

Request frame
The request is made by the master using a "write word" (function 6 or 16) operation at the address 2080h of a 1-word frame consisting of the following:

2080h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Relay number							

The content of the address 2080h may be read using a Modbus "read word" (function 3).
The function code field may have the following values:
■ 01h to 99h (BCD encoding) for protection functions.
The relay number field is used as follows:
■ for protection, it indicates the relay involved, varying from 1 to N, N being the maximum number of relays available in the Sepam
■ when only one relay is available, this number field is not controlled.

Exception replies
In addition to the usual cases, Sepam can send Modbus type 07 exception replies (not acknowledged) if another remote reading request is being processed.

Reply frame
The reply, sent back by the Sepam, fits into a zone containing a maximum of 125 words at the address 2000h which is composed the following:

2000h/207Ch

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Relay number							
Settings															
.....															
(special field for each function)															
.....															

This zone is read by a "read word" operation (function 3) at the address 2000h.
The length of the exchange may include:
■ the first word only (validity test)
■ the maximum size of the zone (125 mots)
■ the usable size of the zone (determined by the function being addressed).
However, reading must always begin at the first word in the zone (any other address triggers an exception reply "incorrect address").
The first word in the zone (function code and relay number) may have the following values:
■ **xxyy**: with
□ function code xx different from 00 and FFh
□ relay number yy different from FFh.
The settings are available and validated. They word is a copy of the "request frame".
The zone contents remain valid until the next request is made.
The other word are not significant.
■ **FFFFh**: the "request frame" has been processed, but the results in the "reply frame" are not yet available. It is necessary to repeat "reply frame" reading.
The other words are not significant.
■ **xxFFh**: with function code xx different from 00 and FFh. The function for which the remote reading request has been made is not valid. The function is not included in the particular Sepam, or remote reading of it is not authorized: refer to the list of functions which accommodate remote reading of settings.

Remote setting

Data that can be remotely set

Writing of the settings of all the protection functions may be accessed remotely.

Exchange principle

Remote setting is allowed for Sepam units.
Remote setting is carried out for a given function, relay by relay.
It takes place in two steps:

- first of all, the master indicates the function code and relay number, followed by the values of all the settings in the a "write request frame". The request is acknowledged to free the network
- the master then reads a reply zone to find the required information by means of a "reply frame", a reply zone designed for checking that the settings have been processed. Each function has its own particular reply zone contents. The contents are same as those of the reply frame.

To use remote setting, it is necessary to make all the settings for the function concerned, even if some of them have not changed.

Request frame

The request is made by the master using a "write n words" (function 16) operation at the address 2100h. The zone to be written contains a maximum of 125 words.
It contains the values of all the settings. It consists of the following:

2100h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Relay number							
Settings															
.....															
(special field for each function)															
.....															

The content of the address 2100h may be read using a "read n words" (function 3).
The function code field may have the following values:

- 01h to 99h (BCD encoding) for the list of protection functions F01 to F99.

The relay number field is used as follows:

- for protection, it indicates the relay involved, varying from 1 to N, N being the maximum number of relays available in the Sepam. It may never be equal to 0.

Exception reply

In addition to the usual cases, Sepam can send type 07 exception replies (not acknowledged) if:

- another remote reading or setting request is being processed
- the remote setting function is inhibited.

Reply frame
The reply sent back by the Sepam is the same as the remote reading reply frame. It fits into a zone containing a maximum of 125 words at the address 2000h and is composed of the effective settings of the function following a semantic check:

2000h-207Ch

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Function code								Relay number							
Settings															
.....															
(special field for each function)															
.....															

This zone is read by a "read n words" operation (function 3) at the address 2000h.
The length of the exchange may unclude:
- the first word only (validity test)
- the maximum size of the reply zone (125 words)
- the usable size of the reply zone (determined by the function being addressed).

However, reading must always begin at the first word in the address zone
(any other address triggers an exception reply "incorrect address").
The first word in the reply zone (function code and relay number) has the same values as those described for the remote reading reply frame.
- **xxyy**: with:
  - function code xx different from 00 and FFh
  - relay number yy different from FFh.

The settings are available and validated. The word is a copy of the "request frame". The zone contents remain valid until the next request is made.
- **0000h**: no "request frame" has been formulated yet, as it is the case, in particular, when the Sepam is switched on.

The other words are not significant.
- **FFFFh**: the "request frame" has been processed, but the results in the "reply frame" are not yet available. It is necessary to repeat "reply frame" reading. The other words are not significant.
- **xxFFh**: with function code xx different from 00 and FFh. The function for which the remote reading request has been made is not valid. The function is not included in that particular Sepam, or access to settings is impossible, both in read and write mode.

Description of settings

Data format

All the settings are transmitted in signed 32-bit whole number form (encoding, as a complement of 2).
Particular setting value:
7FFF FFFFh means that the setting is outside the validity range.

① The Enabled or Disabled setting is encoded as follows:
0 = Disabled, 1 = Enabled

② The tripping curve setting is encoded as follows:

0 = definite
1 = standard inverse time
2 = long time inverse
3 = very inverse time
4 = extremely inverse time
5 = ultra inverse time
6 = RI
7 = IEC SIT/A
8 = IEC LTI/B
9 = IEC VIT/
10 = IEC EIT/C
11 = IEEE Mod. inverse
12 = IEEE Very inverse
13 = IEEE Extr. inverse
14 = IAC inverse
15 = IAC very inverse
16 = IAC extr. inverse

③ The setting of the timer hold curve is encoded as follows:
0 = definite time
1 = IDMT

④ The H2 restraint variable is encoded as follows:
0 = H2 restraint
1 = no H2 restraint

⑤ The tripping curve setting is:
0 = definite time
1 = IDMT

⑥ The negative sequence factor is:
0 = None (0)
1 = Low (2.25)
2 = Average (4.5)
3 = High (9)

⑦ Acknowledgment of the ambient temperature is encoded as follows:
0 = No
1 = Yes

⑧ Not used

⑨ The inhibition input setting is encoded as follows:
0 = No inhibition
1 = Inhibit recloser by logic input I26

⑩ Not used

⑪ The activation mode of each of the cycles is encoded as follows:

Correspondence between bit position and protection according to the table below:

Bit	Activation by
0	Inst O/C 1
1	Time-delayed O/C 1
2	Inst O/C 2
3	Time-delayed O/C 2
4	Inst E/F 1
5	Time-delayed E/F 1
6	Inst E/F 2
7	Time-delayed E/F 2

The bit status is encoded as follows:
0 = No activation by the protection
1 = Activation by the protection.

General characteristics settings (read only)

Function number: 3002

Setting	Data	Format/Unit
1	Rated frequency	0 = 50 Hz 1 = 60 Hz
2	Remote setting enabled	1 = disabled
3	Sepam working language	0 = English 1 = Customized language
4	Number of period before disturbance recording	1
5	Active setting groupe	0 = Setting group A 1 = Setting group B 2 = setting group A and B 3 = Choice by input I13 4 = Choice by remote control 5 = Logic discrimination
6	Setting mode	0 = TMS 1 = 10I/Is
7	Type of phase current sensor	0 = TC 5 A 1 = TC 1 A 2 = LPTC
8	Number of CTs	0 = 3 TC (I1, I2, I3) 1 = 2 TC (I1, I3)
9	Rated current	A
10	Base current	A
11	Residual current mode	0 = 3I sum 1 = 2 A rated CSH 2 = 20 A rated CSH 3 = 1 A CT + CSH 4 = 5 A CT + CSH 5 = ACE990 Range 1 6 = ACE990 Range 2
12	Rated residual current Ino	A
13	Integration period	0 = 5 mn 1 = 10 mn 2 = 15 mn 3 = 30 mn 4 = 60 mn
14	*Reserved*	
15	Rated primary voltage Unp	V
16	Rated secondary voltage Uns	0 = 100 V 1 = 110 V 2 = 115 V 3 = 120 V 4 = 200 V 5 = 230 V
17	Voltages mesured by VTs	0 = 3 V (V1, V2, V3) 1 = 2 U (U21, U32) 2 = 1 U (U21)
18	Residual voltage mode	0 = none 1 = 3 V sum 2 = external VT – Uns/$\sqrt{3}$ 3 = external VT – Uns/3

Protection settings

They are organized according to increasing ANSI codes.

ANSI 27 - Phase-to-phase undervoltage

Function number: 10xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Us set point	% Unp
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 27D/47 - Positive sequence undervoltage

Function number: 08xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Vsd set point	% Unp
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 27R - Remanent undervoltage

Function number: 0901

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Us set point	% Unp
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 27S - Phase-to-neutral undervoltage

Function number: 1801

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Vs set point	% Vnp
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 37 - Phase undercurrent

Function number: 0501

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Is set point	% Ib
3	Tripping time delay	10 ms

ANSI 38/49T - Temperature monitoring

Function number: 15xx
Relay 1 : xx = 01
Relay 2 : xx = 02
Relay 3 : xx = 03
Relay 4 : xx = 04
Relay 5 : xx = 05
Relay 6 : xx = 06
Relay 7 : xx = 07
Relay 8 : xx = 08

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Alarm set point	°C
3	Trip set point	°C
4 to 8	*Reserved*	

ANSI 46 - Negative sequence / unbalance
Function number: 0301

Setting	Data	Format/Unit
1	Enable or disabled	①
2	Tripping curve	⑤
3	Is set point	% Ib
4	Tripping time delay	10 ms

ANSI 48/51LR/14 - Locked rotor, excessive starting time
Function number: 0601

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Is set point	% Ib
3	Excessive starting time delayB (ST)	10 ms
4	Locked rotor time delay (LT)	10 ms
5	Locked rotor on start time delay (LTS)	10 ms

ANSI 49RMS - Thermal overload
Function number: 0401

Setting	Data	Format/Unit
1	Enable or disabled	①
2	Negative sequence factor	⑥
3	Is set point for switching from group A/group B	% Ib
4	Accounting for ambient temperature	⑦
5	Maximum equipment temperature	° C
6	*Reserved*	
7	*Reserved*	
8	Group A - heatrise alarm set point	%
9	Group A - heatrise tripping set point	%
10	Group A - heating time constant	minutes
11	Group A - cooling time constant	minutes
12	Group A - initial heatrise value	%
13	Group B - enabled or disabled	①
14	Group B - heatrise alarm set point	%
15	Group B - heatrise tripping set point	%
16	Group B - heating time constant	minutes
17	Group B - cooling time constant	minutes
18	Group B - initial heatrise value	%

ANSI 50/51 - Phase current
Function number: 01xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	*Reserved*	
2	Group A - tripping curve	②
3	Group A - Is set point	0.1 A
4	Group A - tripping time delay	10 ms
5	Group A - timer hold curve	③
6	Group A - timer hold delay	10 ms
7	*Reserved*	
8	*Reserved*	
9	ON/OFF	①
10	Group B - tripping curve	②
11	Group B - Is set point	0.1 A
12	Group B - tripping time delay	10 ms
13	Group B - timer hold curve	③
14	Group B - timer hold delay	10 ms
15	*Reserved*	
16	*Reserved*	

ANSI 50N/51N or 50G/51G - Earth fault
Function number: 02xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	*Reserved*	
2	Group A - tripping curve	②
3	Group A - Is0 set point	0.1 A
4	Group A - tripping time delay	10 ms
5	Group A - timer hold curve	③
6	Group A - timer hold delay	10 ms
7	Group A - H2 restraint	④
8	*Reserved*	
9	ON/OFF	①
10	Group B - tripping curve	②
11	Group B - Is0 set point	0.1 A
12	Group B - tripping time delay	10 ms
13	Group B - timer hold curve	③
14	Group B - timer hold delay	10 ms
15	Group B - H2 restraint	④
16	*Reserved*	

ANSI 59 - Phase-to-phase overvoltage
Function number: 11xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Us set point	% Unp
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 59N - Neutral voltage displacement
Function number: 12xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Vs0 set point	% Unp
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 66 - Starts per hour
Function number: 0701

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Period of time	hours
3	Total number of starts	1
4	Number of consecutive hot starts	1
5	Number of consecutive starts	1
6	Time delay between starts	minutes

ANSI 79 - Recloser function
Function number: 1701

Setting	Data	Format/Unit
1	Recloser – enabled or disabled	①
2	Recloser inhibition by input I26	⑨
3	Number of cycles	1 to 4
4	Recloser – disengaging time delay	10 ms
5	Recloser – inhibition time delay	10 ms
6	*Reserved*	
7	Cycle 1 – activation mode	⑪
8	Cycle 1 – isolation time delay	10 ms
9	*Reserved*	
10	Cycle 2 – activation mode	⑪
11	Cycle 2 – isolation time delay	10 ms
12	*Reserved*	
13	Cycle 3 – activation mode	⑪
14	Cycle 3 – isolation time delay	10 ms
15	*Reserved*	
16	Cycle 4 – activation mode	⑪
17	Cycle 4 – isolation time delay	10 ms

ANSI 81H - Overfrequency
Function number: 1301

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Fs set point	0.1 Hz
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 81L - Underfrequency
Function number: 14xx
Relay 1: xx = 01
Relay 2: xx = 02

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	Fs set point	0.1 Hz
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

ANSI 81R - Rate of change of frequency
Function number: 1601

Setting	Data	Format/Unit
1	Enabled or disabled	①
2	dFs/dt set point	0.1 Hz/s
3	Tripping time delay	10 ms
4 to 8	*Reserved*	

Presentation

The disturbance recording function is used to record analog and logical signals during a time interval.
Sepam series 20 can store two records.
Each record comprises two files:
- configuration file with suffix .CFG
- data file with suffix .DAT.

The data of each record may be transferred via the Modbus link. It is possible to transfer 1 or 2 records to a remote monitoring and control system. The record may be transferred as many times as possible, until it is overwritten by a new record.
If a record is made by Sepam while the oldest record is being transferred, the oldest record is altered.
If a command (e.g. a remote reading or remote setting request) is carried out during the transfer of a disturbance recording record, the record is not disturbed.

Time-setting
Each record can be dated.
Time-setting of Sepam is described in the "Time-tagging of events" section.

Transferring records

The transfer requests are made record by record, i.e. one configuration file and one data file per record.
The master sends the commands in order to:
- find out the characteristics of the records stored in an identification zone
- read the contents of the different files
- acknowledge each transfer
- reread the identification zone to ensure that the record still appears in the list of records available.

Reading the identification zone
Given the volume of data to be transmitted, the master must ensure that there are data to be recovered and prepare the exchanges when necessary.
The identification zone, described below, is read by the reading of N words starting at the address 2204h:
- 2 reserve words forced to 0
- size of record configuration files encoded in 1 word
- size of record data files encoded in 1 words
- number of records encoded in 1 word
- date of record (most recent) encoded in 4 words (see format below)
- date of record (least recent) encoded in 4 words (see format below)
- 24 reserve words.

All of these data are consecutive.

Reading the contents of the different files

Request frame
The master makes the request by writing the date of the record to be transferred (function 16) in 4 words starting at the address 2200h.
It should be noted that requesting a new record amounts to stopping the transfers which are in progress. This is not the case for an identification zone transfer request.

2200h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
O	O	O	O	O	O	O	O	Y	Y	Y	Y	Y	Y	Y	Y
O	O	O	O	M	M	M	M	O	O	O	D	D	D	D	D
O	O	O	H	H	H	H	H	O	O	mn	mn	mn	mn	mn	mn
ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms	ms

Y - 1 byte for years: varies from 0 to 99 years.
The master must ensure that the year 00 is later than 99.
M - 1 byte for months: varies from 1 to 12.
D - 1 byte for days: varies from 1 to 31.
H - 1 byte for hours: varies from 0 to 23.
mn - 1 byte for minutes: varies from 0 to 59.
ms - 2 bytes for milliseconds: varies from 0 to 59999.

Reply frame
Reading of each portion of configuration and data file records by a reading frame (function 3) of 125-words starting at the address 2300h.

2300h

B15	B14	B13	B12	B11	B10	B09	B08	B07	B06	B05	B04	B03	B02	B01	B00
Exchange number								Number of usable bytes in the data zone							
.....															
Data zone															
.....															

Reading should always begin with the first word in the address zone (any other address triggers an exception reply "incorrect address").
The configuration and data files are read in their entirety in Sepam. They are transferred adjacently.

If the master requests more exchanges than necessary, the exchange number remains unchanged and the number of usable bytes is forced to 0. To guarantee the data transfers, it is necessary to allow a response time of about 500 ms between each reading operation at 2300h.
The first word transmitted is an exchange word. The exchange word comprises two fields:
■ the most significant byte contains the exchange number. It is incremented by 1 by the Sepam each time a successful transfer takes place. When it reaches the value FFh, it automatically goes back to zero
■ the least significant byte contains the number of usable bytes in the data zone. It is initialized to zero after energizing and must be different from FFh.
The exchange word may also have the following values:
■ **xxyy**: the number of usable bytes in the data zone yy must be different from FFh
■ **0000h**: no "read requeste frame" has been formulated yet, as it is the case in particular, when the Sepam is switched on. The other words are not significant,
■ **FFFFh**: the "request frame" has been processed, but the results in the reply zone are not yet available.
It is necessary to repeat "reply frame" reading.
The other words are not significant.
The words which follow the exchange word make up the data zone.
Since the configuration and data files are adjacent, a frame may contain the end of the configuration file and the beginning of the data file of a record.
It is up to the remote monitoring and control system software to reconstruct the files in accordance with the transmitted number of usable bytes and the size of the files indicated in the identification zone.

Acknowledging a transfer
To inform the Sepam that a record block that it has just read has been received correctly, the master must write the number of the last exchange that it has carried out in the "exchange number" filed and set the "number of usable bytes in the data zone" of the exchange word to zero.
The Sepam only increments the exchange number if new acquisition bursts are present.

Rereading the identification zone
To ensure that the record has not been modified, during its transfer by a new record, the master rereads the contents of the identification zone and ensures that the recovered record date is still present.

Reading Sepam identification

Presentation

The "Read Device Identification" function is used to access in a standardized manner the information required to clearly identify a device.
The description is made up of a set of objects (ASCII character strings).
Sepam series 20 accepts the "read identification" function (conformity level 02).
For a complete description of the function, go to **www.modbus.org**. The description below covers a subset of the function, adapted to Sepam series 20.

Implementation

Request frame

The request frame is made of the following components.

Field	*Size (bytes)*	
Slave number	1	
43 (2Bh)	1	*Generic access function code*
14 (0Eh)	1	*Read device identification*
01 or 02	1	*Type of read*
00	1	*Object number*
CRC16	2	

The type of read is used to select a simplified (01) or a standard (02) description.

Reply frame

The reply frame is made of the following components.:

Field	*Size (bytes)*	
Slave number	1	
43 (2Bh)	1	*Generic access function code*
14 (0Eh)	1	*Read device identification*
01 or 02	1	*Type of read*
02	1	*Conformity level*
00	1	*Continuation-frame flag (none for Sepam)*
00	1	*Reserved*
n	1	*Number of objects (according to read type)*
0bj1	1	*Number of first object*
lg1	1	*Length first object*
txt1	lg1	*ASCII string of first object*
.....	...	
objn	1	*Number n^{th} object*
lgn	1	*Length n^{th} object*
txtn	lgn	*ASCII string of n^{th} object*
CRC16	2	

Exception frame

If an error occurs during request processing, a special exception frame is sent.

Field	*Size (bytes)*	
Slave number	1	
171 (ABh)	1	*Generic access exception (2Bh + 80h)*
14 (0Eh)	1	*Read device identification*
01 or 03	1	*Type of error*
CRC16	2	

Sepam series 20 identification

The objects making up the Sepam series 20 identification are listed below.

Number	Type	Value
0	VendorName	"Merlin Gerin"
1	ProductCode	Application EAN13 code
2	MajorMinorRevision	Application version number (Vx.yy)
3	VendorURL	"www.schneider-electric.com"
4	ProductName	"Sepam series 20"
5	ModelName	Application name (e.g. "M20 Motor")
6	UserAppName	Sepam marking

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Precautions
Equipment identification

Precautions

We recommend that you follow the instructions given in this document for quick, correct installation of your Sepam:
- equipment identification
- assembly
- connection of current and voltage inputs, probes
- connection of power supply
- checking prior to commissioning.

Handling, transport and storage

Sepam in its original packaging

Transport:
Sepam may be shipped to any destination without talking any additional precautions by all usual means of transport.

Handling:
Sepam may be handled without any particular care and can even withstand being dropped by a person handling it (person standing on floor).

Storage:
Sepam may be stored in its original packaging, in an appropriate location for several years:
- temperature between -25 °C and +70 °C
- humidity ⩽ 90 %.

Periodic, yearly checking of the environment and the packaging condition is recommended.
Once Sepam has been unpacked, it should be energized as soon as possible.

Sepam installed in a cubicle

Transport:
Sepam may be transported by all usual means of transport in the customary conditions used for cubicles. Storage conditions should be taken into consideration for a long period of transport.

Handling:
Should the Sepam fall out of a cubicle, check its condition by visual inspection and energizing.

Storage:
Keep the cubicle protection packing for as long as possible. Sepam, like all electronic units, should not be stored in a damp environment for more than a month. Sepam should be energized as quickly as possible. If this is not possible, the cubicle reheating system should be activated.

Environment of the installed Sepam

Operation in a damp environment
The temperature/relative humidity factors must compatible with the unit's environmental withstand characteristics.
If the use conditions are outside the normal zone, commissioning arrangements should be made, such as air conditioning of the premises.

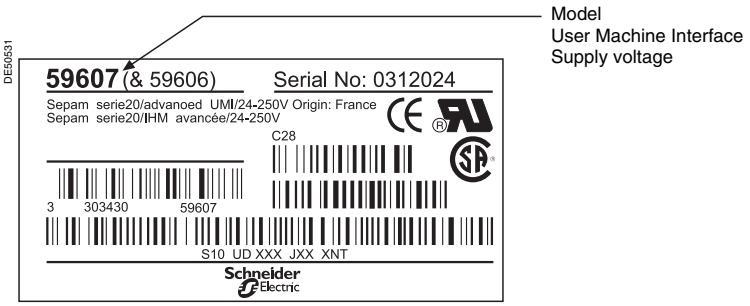
Operation in a polluted atmosphere
A contaminated industrial atmosphere components (such as the presence of chlorine, hydrofluoric acid, sulfur, solvents...) may cause corrosion of the electronic components, in which case environmental control arrangements should be made (such as closed, pressurized premises with filtered air, ...) for commissioning.
The effect of corrosion on Sepam has been tested according to the IEC 60068-2-60 standard. Sepam is certified level C under the following test conditions: 21 days, 25 °C, 75 % relative humidity, 1 ppm H_2S, 0.5 ppm SO_2.

Equipment identification

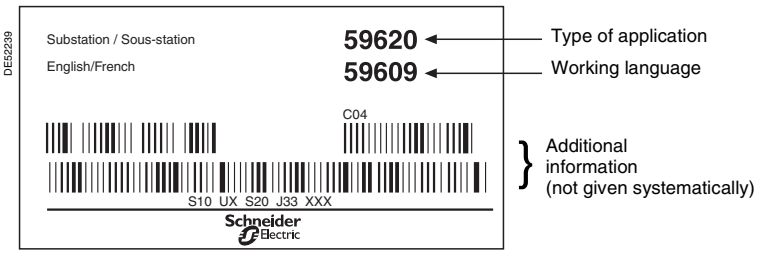
Identification of the base unit

Each Sepam comes in a single package which contains the base unit and the base unit 20-pin connector (CCA620 or CCA622).
The other optional accessories such as mdoules, current or voltage input connectors and cords come in separate packages.
To identify a Sepam, check the 2 labels on the right side panel of the base unit which describe the product's functional and hardware features.

- hardware reference and designation

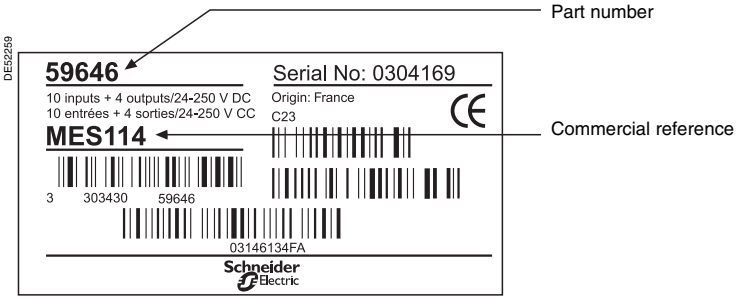


- functional reference and designation



Identification of accessories

The accessories such as optional modules, current or voltage connectors and connection cords come in separate packages, identified by labels.
- example of MES114 module identification label:



Equipment identification

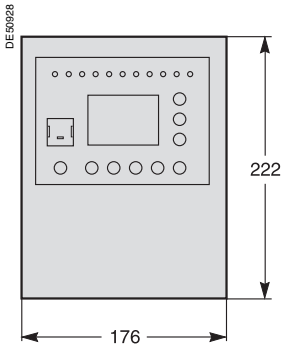
List of Sepam series 20 references

Reference	Designation
59603	Base unit with basic UMI, 24-250 V DC and 100-240 V AC power supply (1)
59607	Base unit with advanced UMI, 24-250 V DC and 100-240 V AC power supply (1)
59608	DSM303, remote advanced UMI module
59609	Working language English/French
59611	Working language English/Spanish
59620	Substation application type S20
59621	Transformer application type T20
59622	Motor application type M20
59624	Busbar application type B21
59625	Busbar application type B22
59630	CCA630 connector for 1A/5A CT current sensors
59631	CCA670 connector for LPCT current sensors
59632	CCT640 connector for VT voltage sensors
59634	CSH30 interposing ring CT for Io input
59635	CSH120 residual current sensor, diameter 120 mm
59636	CSH200 residual current sensor, diameter 200 mm
59639	AMT852 lead sealing accessory
59641	MET148-2 8-temperature sensor module
59642	ACE949-2-wire RS 485 network interface
59643	ACE959 4-wire RS 485 network interface
59644	ACE937 optical fibre interface
59646	MES114 10 input + 4 output module / 24-250 V DC (1)
59647	MSA141 1 analog output module
59648	ACE909-2 RS 485/RS 232 convertor
59649	ACE919CA RS 485/RS 485 interface (AC power supply)
59650	ACE919CC RS 485/RS 485 interface (CC power supply)
59651	MES114E 10 input + 4 output module / 110-125 V DC and V AC
59652	MES114F 10 input + 4 output module / 220-250 V DC and V AC
59660	CCA770 remote module cord, L = 0.6 m
59661	CCA772 remote module cord, L = 2 m
59662	CCA774 remote module cord, L = 4 m
59663	CCA612 RS 485 network interface communication cord, L = 3 m
59664	CCA783 PC connection cord
59666	CCA613 LPCT remote test plug
59667	ACE917 LPCT injection adapter
59668	CCA620 20-pin screw type connector
59669	CCA622 20-pin ring lug connector
59670	AMT840 mounting plate
59672	ACE990 core balance CT interface for Io input
59676	Kit 2640 2 sets of spare connectors
59679	SFT2841 CD-ROM with SFT2841 and SFT2826 software without CCA783 cord
59720	ACE969TP 2-wire RS 485 multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103)
59721	ACE969FO fiber-optic multi-protocol interface (Modbus, DNP3 or IEC 60870-5-103)

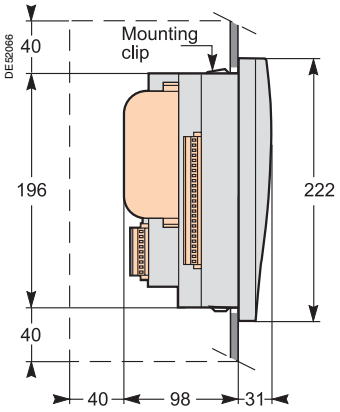
(1) *List of references cancelled and replaced:*
■ *59602 (base unit with basic UMI, 24 V DC power supply) cancelled and replaced by reference 59603*
■ *59606 (base unit with advanced UMI, 24 V DC power supply) cancelled and replaced by reference 59607*
■ *59645 (MES108 4I/4O module) cancelled and replaced by reference 59646.*

Base unit
Dimensions

Dimensions



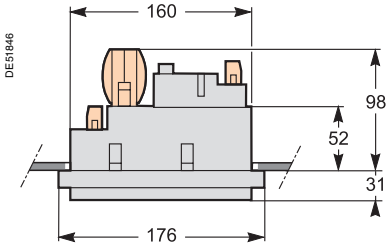
Front view of Sepam.



Side view of Sepam with advanced UMI and MES114, flush-mounted in front panel.

Clearance for Sepam assembly and wiring.

***(1)** With basic UMI: 23 mm.*



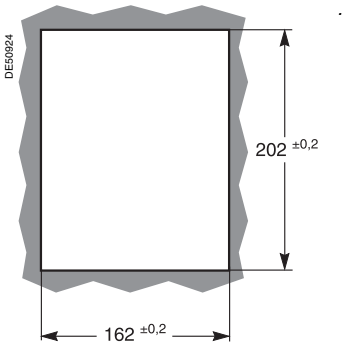
Top view of Sepam with advanced UMI and MES114, flush-mounted in front panel.

***(1)** With basic UMI: 23 mm.*

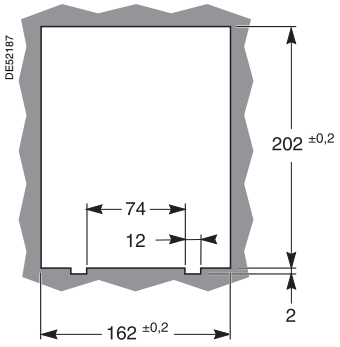
Cut-out

Cutout accuracy must be complied with to ensure good withstand.

For mounting plate between 1.5 mm and 3 mm thick

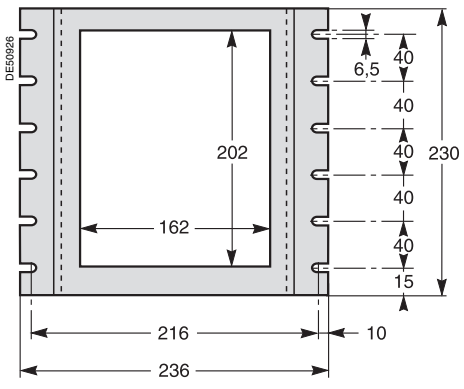


For mounting plate 3.17 mm (0.125 inch) thick

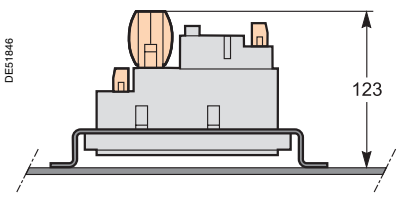


Assembly with AMT840 mounting plate

Used to mount Sepam at the back of the compartment with access to the connectors on the rear panel.
Mounting associated with the use of the remote advanced UMI (DSM303).



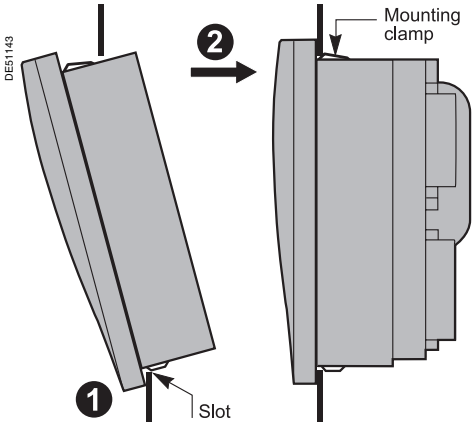
AMT840 mounting plate.



Sepam with basic UMI and MES114, mounted with AMT840.
Mounting plate: 2 mm thick.

Base unit
Assembly

The Sepam is simply flush-mounted and clamped, without requiring any additional screw type fastening.



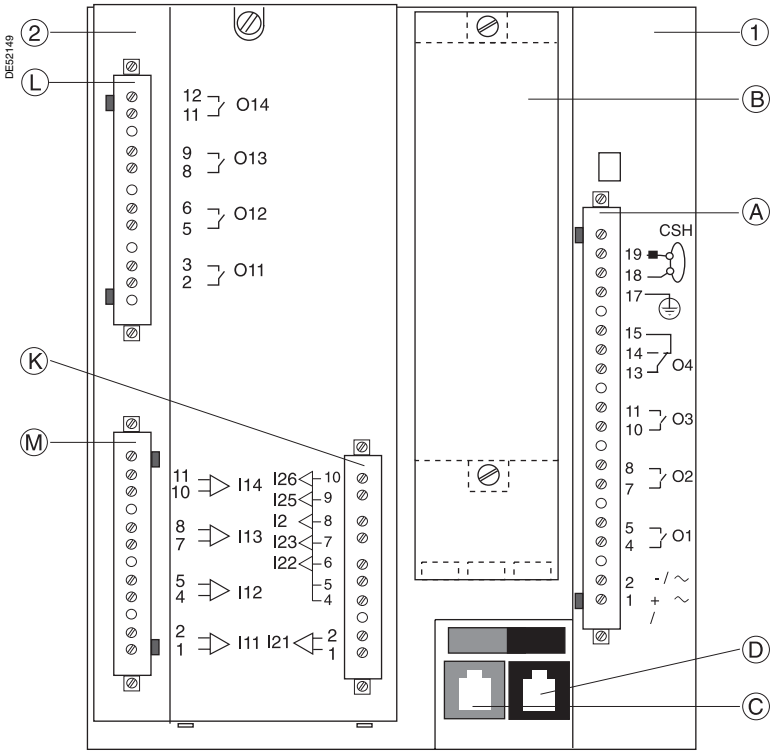
① Present the product as indicated, making sure the metal plate is correctly entered in the groove at the bottom.
② Tilt the product and press on the top part to clamp it with the clips.

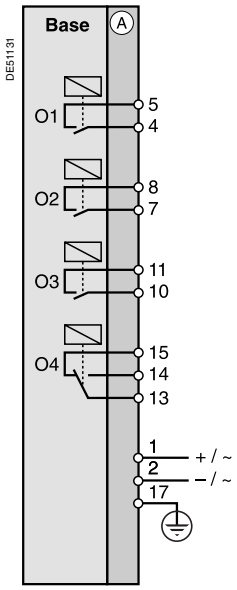
Base unit
Connection

Sepam components

■ base unit ①
□ Ⓐ base unit connector:
- power supply
- output relay
- CSH30, 120, 200 or ACE990 input.

Screw-type connector shown (CCA620), or ring lug connector (CCA622)
□ Ⓑ 1/5 A CT current input connector (CCA630) or LPCT current input connector (CCA670) or voltage input connector (CCT640)
□ Ⓒ communication module link connection (green)
□ Ⓓ remote inter-module link connection (black)
■ optional input/output module ② (MES108 or MES114)
□ Ⓛ Ⓜ MES108 or MES114 module connectors
□ Ⓚ MES114 module connector.





Connection of the base unit

The Sepam connections are made to the removable connectors located on the rear panel. All the connectors are screw-lockable.

For safety reasons (access to dangerous potentials), all the terminals must be screwed tight, whether or not they are used.

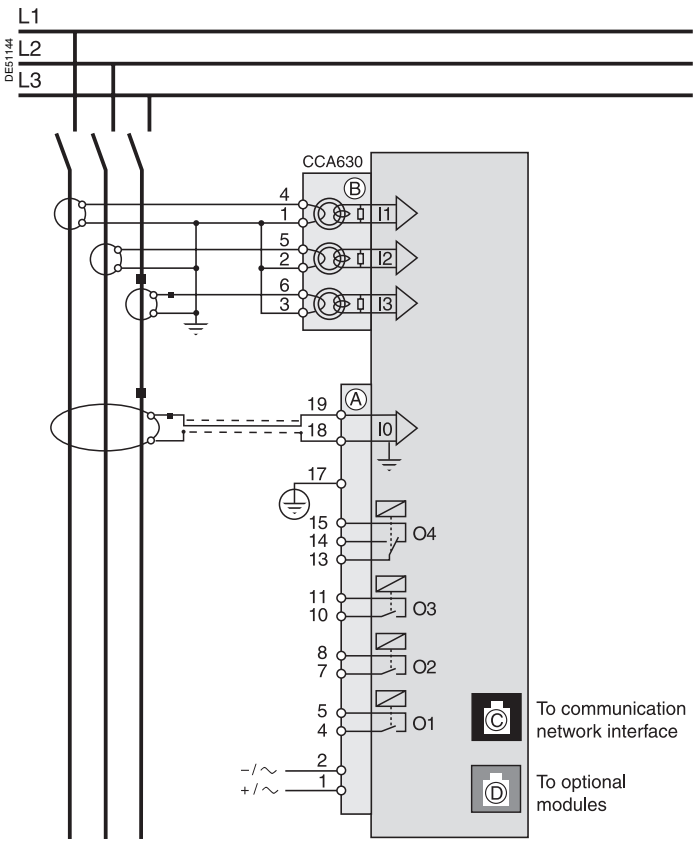
Wiring of the CCA620 connector:
■ without fitting:
□ 1 wire with maximum cross-section of 0.2 to 2.5 mm² (⩾ AWG 24-12) or 2 wires with maximum cross-section of 0.2 to 1 mm² (⩾ AWG 24-16)
□ stripped length: 8 to 10 mm
■ with fitting:
□ recommended wiring with Telemecanique fitting:
- DZ5CE015D for 1 wire 1.5 mm²
- DZ5CE025D for 1 wire 2.5 mm²
- AZ5DE010D for 2 wires 1 mm²

□ tube length: 8.2 mm
□ stripped length: 8 mm.

Wiring of the CCA622 connector:
■ ring lug connectors 6.35 mm (1/4").

Characteristics of the 4 base unit relay outputs O1, O2, O3, O4:
■ O1 and O2 are 2 control outputs, used by the breaking device control function for:
□ O1: breaking device tripping
□ O2: breaking device closing inhibition
■ O3 and O4 are indication outputs, only O4 may be activated by the watchdog function.

Base unit
Connection of current input



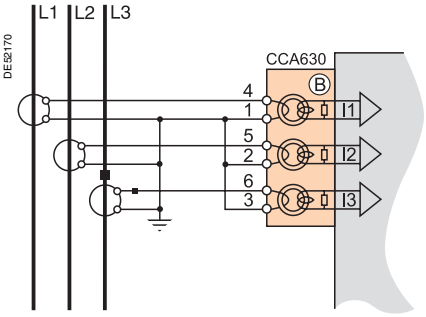
S20 / T20 / M20 types

Connection to 1 A / 5 A current sensors

Connector	Type	Ref.	Cable
A	Screw-type	CCA620	1 wire 0.2 to 2.5 mm² (≥ AWG 24-12) 2 wires 0.2 to 1 mm² (≥ AWG 24-16)
	Ring lug 6.35 mm	CCA622	
B	Ring lug 4 mm	CCA630	1.5 to 6 mm² (AWG 16 to AWG 10)
C	RJ45		CCA612
D	RJ45		CCA770: L = 0.6 m CCA772: L = 2 m CCA774: L = 4 m

Base unit
Other current input connection schemes

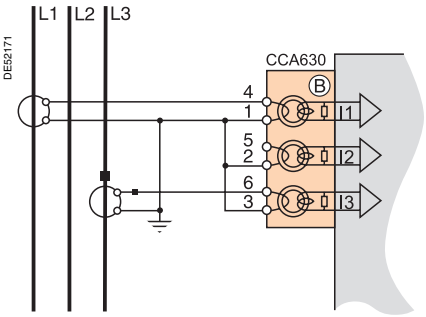
Variant 1: phase current measurement by 3 x 1 A or 5 A CTs (standard connection)



Connection of 3 x 1 A or 5 A sensors to the CCA630 connector.

The measurement of the 3 phase currents allows the calculation of residual current.

Variant 2: phase current measurement by 2 x 1 A or 5 A CTs

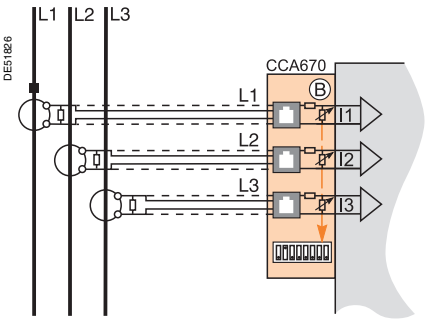


Connection of 2 x 1 A or 5 A CTs to the CCA630 connector.

The measurement of phase currents 1 and 3 is sufficient to ensure all the current-based protection functions.

This arrangement does not allow the calculation of residual current.

Variant 3: phase current measurement by 3 LPCT type sensors



Connection of 3 Low Power Current Transducer (LPCT) type sensors to the CCA670 connector. The connection of just one or two sensors is not allowed and causes Sepam to switch to the fallback position.

The measurement of the 3 phase currents allows the calculation of residual current.

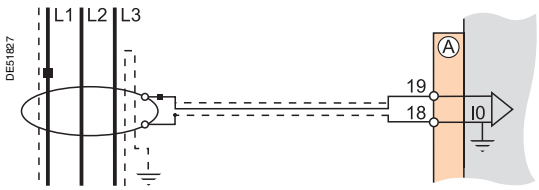
The In parameter, primary rated current measured by an LPCT, is to be chosen from the following values, in Amps: 25, 50, 100, 125, 133, 200, 250, 320, 400, 500, 630, 666, 1000, 1600, 2000, 3150.
Parameter to be set using the advanced UMI and the SFT2841 software tool, to be completed by hardware setting of the microswitches on the CCA670 connector.

Base unit
Other residual current input connection schemes

Variant 1: residual current calculation by sum of 3 phase currents

Residual current is calculated by the vector sum of the 3 phase currents I1, I2 and I3, measured by 3 x 1 A or 5 A CTs or by 3 LPCT type sensors.
See current input connection diagrams.

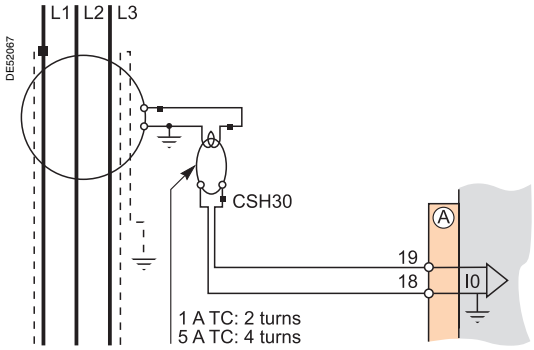
Variant 2: residual current measurement by CSH120 or CSH200 core balance CT (standard connection)



Arrangement recommended for the protection of isolated or compensated neutral systems, in which very low fault currents need to be detected.

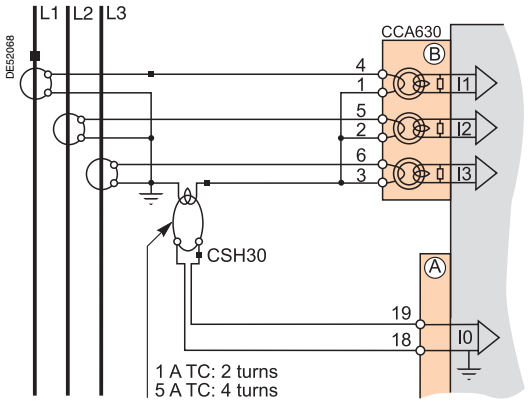
Setting range from 0.1 In0 to 15 In0,
with In0 = 2 A or 20 A according to parameter setting.

Variant 3: residual current measurement by 1 A or 5 A CTs and CSH30 interposing ring CT

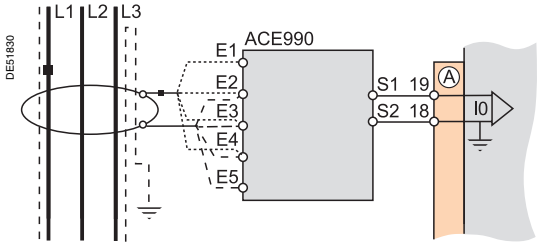


The CSH30 interposing ring CT is used to connect 1 A or 5 A CTs to Sepam to measure residual current:
- CSH30 interposing ring CT connected to 1 A CT: make 2 turns through CSH primary
- CSH30 interposing ring CT connected to 5 A CT: make 4 turns through CSH primary.

Setting range from 0.1 In to 15 In, with In = CT primary current.



Variant 4: residual current measurement by core balance CT with ratio of 1/n (n between 50 and 1500)

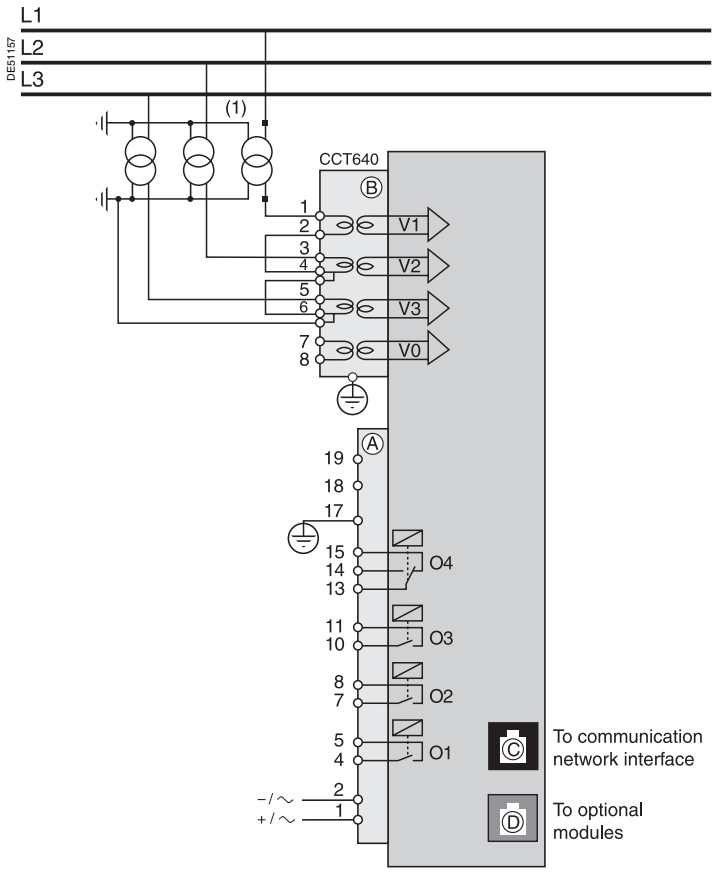


The ACE990 is used as an interface between a MV core balance CT with a ratio of 1/n (50 ⩽ n ⩽ 1500) and the Sepam residual current input.
This arrangement allows the continued use of existing core balance CTs on the installation.

Setting range from 0.1 In0 to 15 In0, with In0 = k.n,
where n = n = number of core balance CT turns
and k = factor to be determined according to ACE990 wiring and setting range used by Sepam, with a choice of 20 discrete values from 0.00578 to 0.26316.

Base unit
Connection of voltage inputs

B21 and B22 types

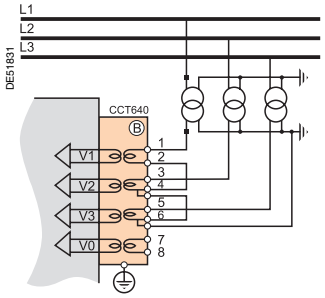


Connector	Type	Ref.	Cable
A	Screw-type	CCA620	1 wire 0.2 to 2.5 mm² (≥ AWG 24-12) 2 wires 0.2 to 1 mm² (≥ AWG 24-16)
	Ring lug 6.35 mm	CCA622	
B	Screw-type	CCT640	1 wire 0.2 to 2.5 mm² (≥ AWG 24-12) 2 wires 0.2 to 1 mm² (≥ AWG 24-16)
C	RJ45		CCA612
D	RJ45		CCA770: L = 0.6 m CCA772: L = 2 m CCA774: L = 4 m

Base unit
Other voltage input connection schemes

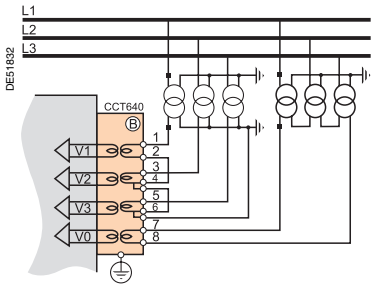
The phase and residual voltage transformer secondary circuits are connected to the CCT640 connector (item Ⓑ) on Sepam B21 and B22. The CCT640 connector contains 4 transformers which perform isolation and impedance matching of the VTs and Sepam input circuits.

Variant 1: measurement of 3 phase-to-neutral voltages (standard connection)



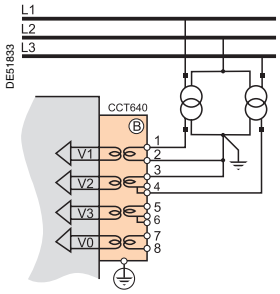
Phase voltage sensor parameter setting	3V
Residual voltage sensor parameter setting	3V sum
Voltages measured	V1, V2, V3
Values calculated	U21, U32, U13, V0, Vd, f
Measurements unavailable	None
Protection functions unavailable (according to type of Sepam)	None

Variant 2: measurement of 3 phase-to-neutral voltage and residual voltage



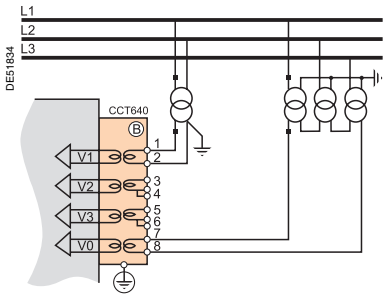
Phase voltage sensor parameter setting	3V
Residual voltage sensor parameter setting	External VT
Voltages measured	V1, V2, V3, V0
Values calculated	U21, U32, U13, Vd, f
Measurements unavailable	None
Protection functions unavailable (according to type of Sepam)	None

Variant 3: measurement of 2 phase-to-phase voltages



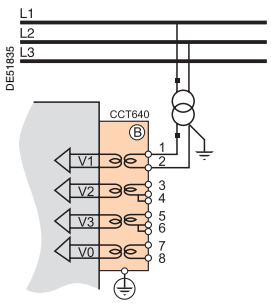
Phase voltage sensor parameter setting	U21, U32
Residual voltage sensor parameter setting	None
Voltages measured	U21, U32
Values calculated	U13, Vd, f
Measurements unavailable	V1, V2, V3, V0
Protection functions unavailable (according to type of Sepam)	59N, 27S

Variant 4: measurement of 1 phase-to-phase voltage and residual voltage



Phase voltage sensor parameter setting	U21
Residual voltage sensor parameter setting	External VT
Voltages measured	U21, V0
Values calculated	f
Measurements unavailable	U32, U13, V1, V2, V3, Vd
Protection functions unavailable (according to type of Sepam)	47, 27D, 27S

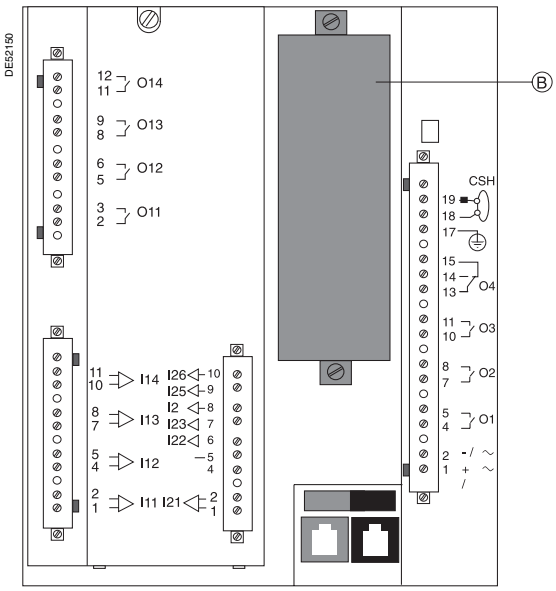
Variant 5: measurement of 1 phase-to-phase voltage



Phase voltage sensor parameter setting	U21
Residual voltage sensor parameter setting	None
Voltages measured	U21
Values calculated	f
Measurements unavailable	U32, U13, V1, V2, V3, V0, Vd
Protection functions unavailable (according to type of Sepam)	47, 27D, 59N, 27S

1 A or 5 A CT block and connection diagram

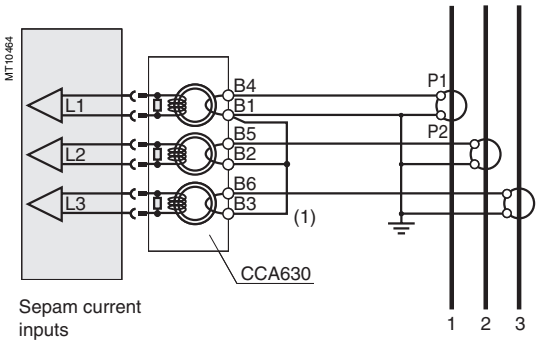
The current transformer (1 A or 5 A) secondary windings are connected to the CCA630 connector, item Ⓑ.



CCA630 connector

The connector contains 3 interposing ring CTs with through primaries, which ensure impedance matching and isolation between the 1 A or 5 A circuits and Sepam.

The connector may be disconnected with the power on since disconnection does not open the CT secondary circuits.



(1) *Bridging strap supplied with the CCA630.*

CCA630 wiring

- open the 2 side shields for access to the connection terminals. The shields may be removed, if necessary, to make wiring easier. If removed, they must be replaced after wiring
- remove the bridging strap, if necessary. The strap links terminals 1, 2 and 3
- connect the wires using 4 mm ring lugs and check the tightness of the 6 screws that guarantee the continuity of the CT secondary circuits. The connector accommodates wires with cross-sections of 1.5 to 6 mm^2 (AWG 16 to AWG 10)
- close the side shields
- plug the connector into the 9-pin inlet on the rear panel, item Ⓑ
- tighten the 2 CCA630 connector fastening screws on the rear panel of Sepam.

LPCT sensor block and connection diagram

The 3 LPCT current transformers are connected to the CCA670 connector mounted in the rear panel of Sepam, item Ⓑ.

The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into the failsafe position.

CCA670 connector parameter setting

The CCA670 connector should be calibrated at the time of Sepam commissioning according to the following instructions:

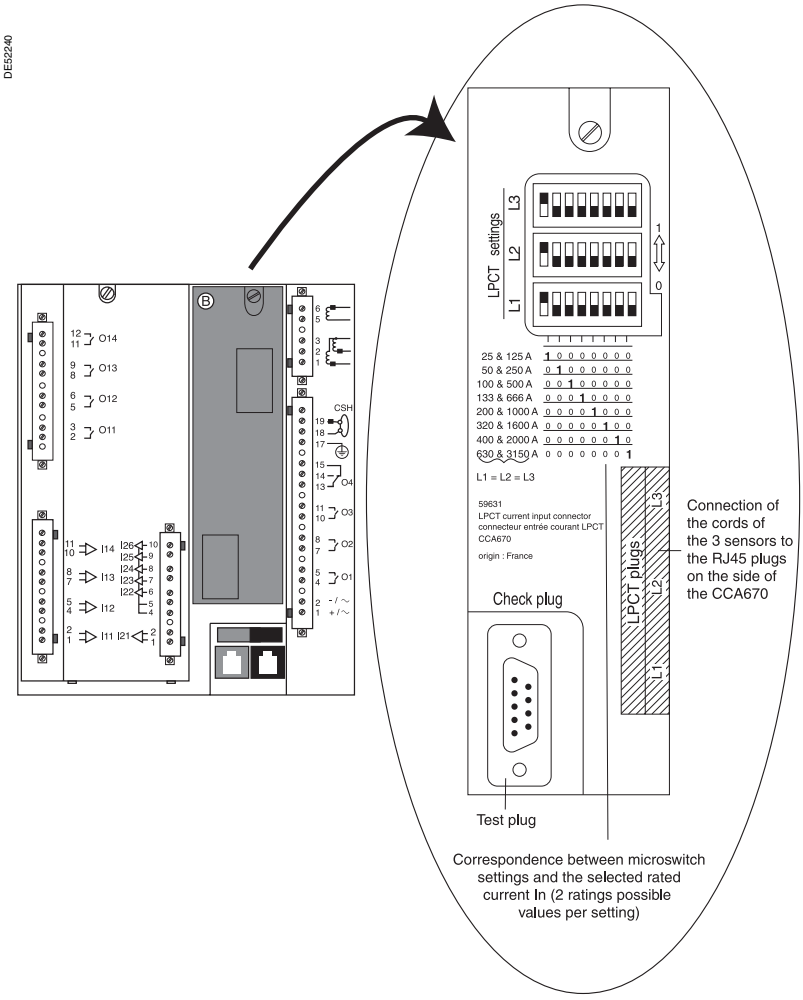
■ use a screwdriver to remove the shield located in the “LPCT settings” zone; the shield protects 3 blocks of 8 microswitches marked L1, L2, L3

■ on the L1 block, set the microswitch that corresponds to the selected rated current to "1" (2 ratings possible for each position)

□ the rated current should be the same as the one set in Sepam ("General characteristics“ menu via the SFT2841 software tool, “Current sensors" screen with advanced UMI)

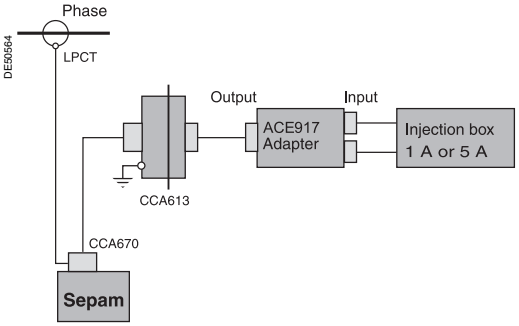
□ leave the 7 other microswitches set to “0”

■ set the other 2 blocks of switches L2 and L3 to the same position as block L1 and close the shield.

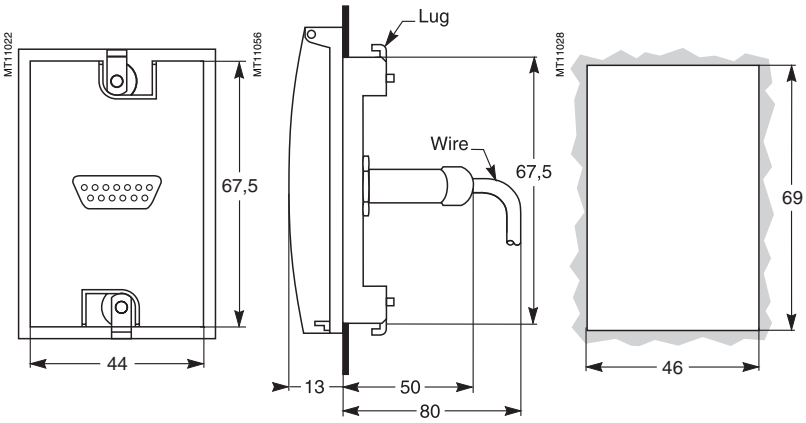


CCA613 remote test plug

The CCA613 test plug, panel-mounted on the front of the cubicle and fitted with a 2-meter cord, is used to transfer data from the integrated test plug to the CCA670 interface connector on the rear panel of Sepam.



Accessory connection principle.



Front view with cover lifted. *Right side view.* *Cut out.*

CSH120 and CSH200 Core balance CTs

PE50032

CSH120 and CSH200 core balance CTs.

Function

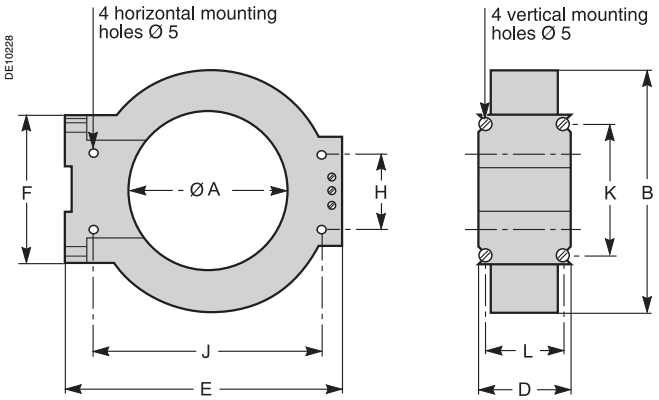
The specifically designed CSH120 and CSH200 core balance CTs are used for direct residual current measurement. The only difference between them is the diameter. Due to their low voltage insulation, they may only be used on cables.

Characteristics

	CSH120	CSH200
Inner diameter	120 mm	200 mm
Weight	0.6 kg	1.4 kg
Accuracy	±5 % to 20 °C	
	±6 % max. from -25 °C to 70 °C	
Transformation ratio	1/470	
Maximum permissible current	20 kA - 1 s	
Operating temperature	-25 °C to +70 °C	
Storage temperature	-40 °C to +85 °C	

Dimensions

DE10228



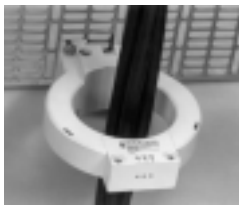
Dimensions	A	B	D	E	F	H	J	K	L
CSH120	120	164	44	190	76	40	166	62	35
CSH200	200	256	46	274	120	60	257	104	37

The CSH120 and CSH200 core balance CTs must be installed on insulated cables.
Cables with a rated voltage of more than 1000 V must also have an earthed shielding.

E40465

Assembly on MV cables.

E40466

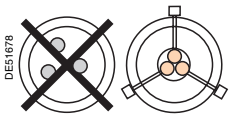


Assembly on mounting plate.

Assembly

Group the MV cable (or cables) in the middle of the core balance CT.
Use non-conductive binding to hold the cables.
Remember to insert the 3 medium voltage cable shielding earthing cables through the core balance CT.

DE51678



Connection

Connection to Sepam series 20 and Sepam series 40

To residual current I0 input, on connector (A), terminals 19 and 18 (shielding).

Connection to Sepam series 80

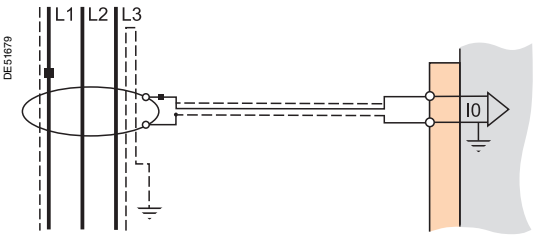
- to residual current I0 input, on connector (E), terminals 15 and 14 (shielding)
- to residual current I'0 input, on connector (E), terminals 18 and 17 (shielding).

Recommended cable

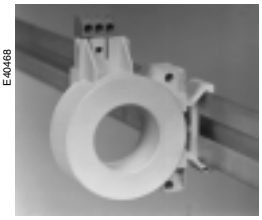
- sheathed cable, shielded by tinned copper braid
- minimum cable cross-section 0.93 mm² (AWG 18)
- resistance per unit length < 100 mΩ/m
- minimum dielectric strength: 1000 V (700 Vrms).

It is essential for the CSH30 to be installed near Sepam (Sepam - CSH30 link less than 2 m.
Flatten the connection cable against the metal frames of the cubicle.
The connection cable shielding is grounded in Sepam. Do not ground the cable by any other means.
The maximum resistance of the Sepam connection wiring must not be more than 4 Ω (or 20 m maximum for 100 mΩ/m).

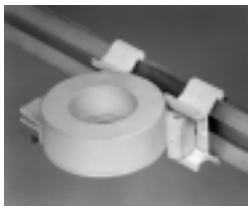
DE51679



CSH30 interposing ring CT



Vertical assembly of CSH30 interposing ring CT.



Horizontal assembly of CSH30 interposing ring CT.

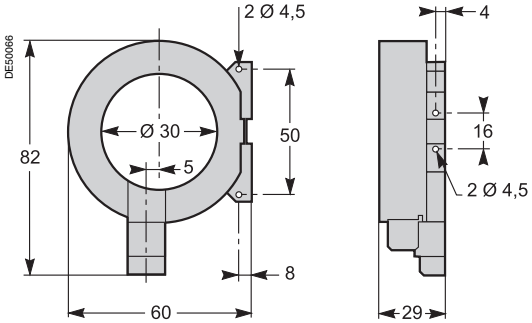
Function

The CSH30 interposing ring CT is used as an interface when the residual current is measured using 1 A or 5 A current transformers.

Characteristics

Weight	0.2 kg
Assembly	On symmetrical DIN rail In vertical or horizontal position

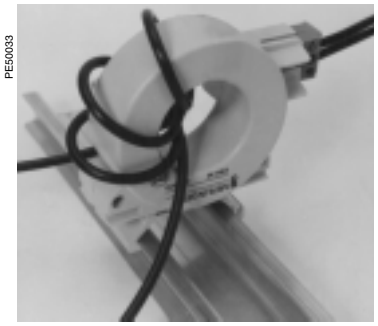
Dimensions



Connection

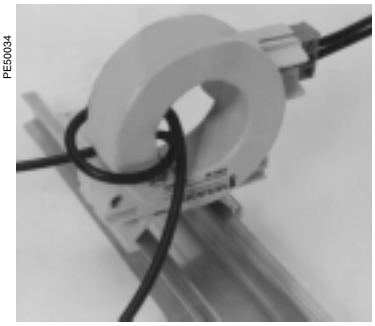
The CSH30 is adapted for the type of current transformer, 1 A or 5 A, by the number of turns of the secondary wiring through the CSH30 interposing ring CT:
- 5 A rating - 4 turns
- 1 A rating - 2 turns.

Connection to 5 A secondary circuit

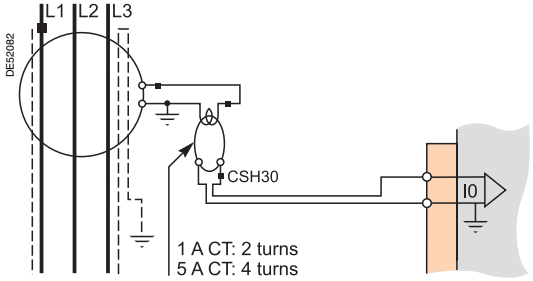


- plug into the connector
- insert the transformer secondary wire through the CSH30 core balance CT 4 times.

Connection to 1 A secondary circuit



- plug into the connector
- insert the transformer secondary wire through the CSH30 core balance CT twice.



Connection to Sepam series 20 and Sepam series 40

To residual current I0 input, on connector (A), terminals 19 and 18 (shielding).

Connection to Sepam series 80

- to residual current I0 input, on connector (E), terminals 15 and 14 (shielding)
- to residual current I'0 input, on connector (E), terminals 18 and 17 (shielding).

Recommended cable

- sheathed cable, shielded by tinned copper braid
- minimum cable cross-section 0.93 mm² (AWG 18) (max. 2.5 mm²)
- resistance per unit length < 100 mΩ/m
- minimum dielectric strength: 1000 V (700 Vrms).

It is essential for the CSH30 to be installed near Sepam (Sepam - CSH30 link less than 2 meters long).
Flatten the connection cable against the metal frames of the cubicle.
The connection cable shielding is grounded in Sepam. Do not ground the cable by any other means.
The maximum resistance of the Sepam connection wiring must not be more than 4 Ω.

ACE990
Core balance CT interface

PE50037

ACE990 core balance CT interface.

Function

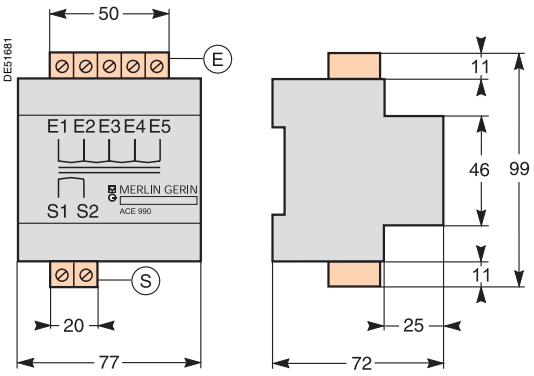
The ACE990 interface is used to adapt measurements between a MV core balance CT with a ratio of 1/n (50 ⩽ n ⩽ 1500), and the Sepam residual current input.

Characteristics

Weight	0.64 kg
Assembly	Mounted on symmetrical DIN rail
Amplitude accuracy	±1 %
Phase accuracy	< 2°
Maximum permissible current	20 kA - 1 s (on the primary winding of a MV core balance CT with a ratio of 1/50 that does not saturate)
Operating temperature	-5 °C to +55 °C
Storage temperature	-25 °C to +70 °C

Description and dimensions

DE51681

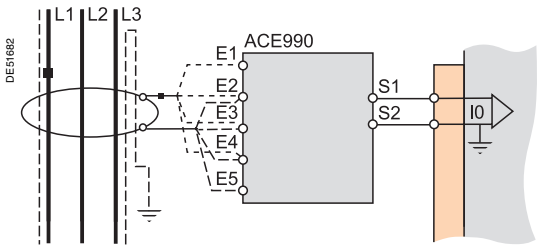


(E) ACE990 input terminal block, for connection of the core balance CT.

(S) ACE990 output terminal block, for connection of the Sepam residual current input.

6

ACE990
Core balance CT interface



Terminals connection

Connection of core balance CT

Only one core balance CT may be connected to the ACE990 interface.
The secondary circuit of the MV core balance CT is connected to 2 of the 5 ACE990 interface input terminals. To define the 2 inputs, it is necessary to know the following:

- core balance CT ratio (1/n)
- core balance CT power
- close approximation of rated current In0

(In0 is a Sepam general setting and defines the earth fault protection setting range between 0.1 In0 and 15 In0).

The table below may be used to determine:

- the 2 ACE990 input terminals to be connected to the MV core balance CT secondary
- the type of residual current sensor to set
- the exact value of the rated residual current In0 setting, given by the following formula: **In0 = k x number of core balance CT turns**

with k the factor defined in the table below.

The core balance CT must be connected to the interface in the right direction for correct operation: the MV core balance CT secondary output terminal S1 must be connected to the ACE990 input terminal with the lowest index (Ex).

K value	ACE990 input terminals to be connected	Residual current sensor setting	Min. MV core balance CT power
0.00578	E1 - E5	ACE990 - range 1	0.1 VA
0.00676	E2 - E5	ACE990 - range 1	0.1 VA
0.00885	E1 - E4	ACE990 - range 1	0.1 VA
0.00909	E3 - E5	ACE990 - range 1	0.1 VA
0.01136	**E2 - E4**	**ACE990 - range 1**	**0.1 VA**
0.01587	E1 - E3	ACE990 - range 1	0.1 VA
0.01667	E4 - E5	ACE990 - range 1	0.1 VA
0.02000	E3 - E4	ACE990 - range 1	0.1 VA
0.02632	E2 - E3	ACE990 - range 1	0.1 VA
0.04000	E1 - E2	ACE990 - range 1	0.2 VA
0.05780	E1 - E5	ACE990 - range 2	2.5 VA
0.06757	E2 - E5	ACE990 - range 2	2.5 VA
0.08850	E1 - E4	ACE990 - range 2	3.0 VA
0.09091	E3 - E5	ACE990 - range 2	3.0 VA
0.11364	E2 - E4	ACE990 - range 2	3.0 VA
0.15873	E1 - E3	ACE990 - range 2	4.5 VA
0.16667	E4 - E5	ACE990 - range 2	4.5 VA
0.20000	E3 - E4	ACE990 - range 2	5.5 VA
0.26316	E2 - E3	ACE990 - range 2	7.5 VA

Example:
Given a core balance CT with a ratio of 1/400 2 VA, used within a measurement range of 0.5 A to 60 A.
How should it be connected to Sepam via the ACE990?

1. *Choose a close approximation of the rated current In0, i.e. 5 A.*
2. *Calculate the ratio: approx. In0/number of turns = 5/400 = 0.0125.*
3. *Find the closest value of k in the table opposite: k = 0.01136.*
4. *Check the mininum power required for the core balance CT: 2 VA core balance CT > 0.1 VA ➡ OK.*
5. *Connect the core balance secondary to ACE990 input terminals E2 and E4.*
6. *Set Sepam up with: In0 = 0.0136 x 400 = 4.5 A. This value of In0 may be used to monitor current between 0.45 A and 67.5 A.*

Wiring of MV core balance secondary circuit:

- *MV core balance CT S1 output to ACE990 E2 input terminal*
- *MV core balance CT S2 output to ACE990 E4 input terminal.*

Connection to Sepam series 20 and Sepam series 40

To residual current I0 input, on connector (A), terminals 19 and 18 (shielding).

Connection to Sepam series 80

- to residual current I0 input, on connector (E), terminals 15 and 14 (shielding)
- to residual current I'0 input, on connector (E), terminals 18 and 17 (shielding).

Recommended cables

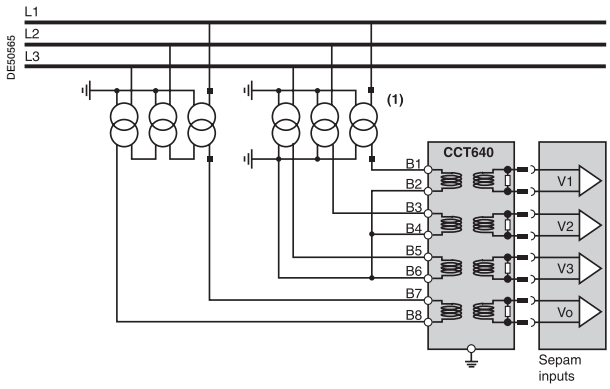
- cable between core balance CT and ACE990: less than 50 m long
- sheathed cable, shielded by tinned copper braid between the ACE990 and Sepam, maximum length 2 m
- cable cross-section between 0.93 mm² (AWG 18) and 2.5 mm² (AWG 13)
- resistance per unit length less than 100 mΩ/m
- minimum dielectric strength: 100 Vrms.

Connect the ACE990 connection cable shielding in the shortest manner possible (2 cm maximum) to the shielding terminal on the Sepam connector.
Flatten the connection cable against the metal frames of the cubicle.
The connection cable shielding is grounded in Sepam. Do not ground the cable by any other means.

The phase and residual voltage transformer secondary circuits are connected to the CCT640 connector, item Ⓑ on B2X type Sepam units.

CCT640

The connector contains 4 transformers which provide impedance matching and isolation between the VTs and Sepam input circuits.
Terminals B1 to B6 are intended for phase voltage measurement **(1)**, and B7 and B8 for residual voltage measurement (case shown, not connected if obtained by the sum of the 3 phase voltages).



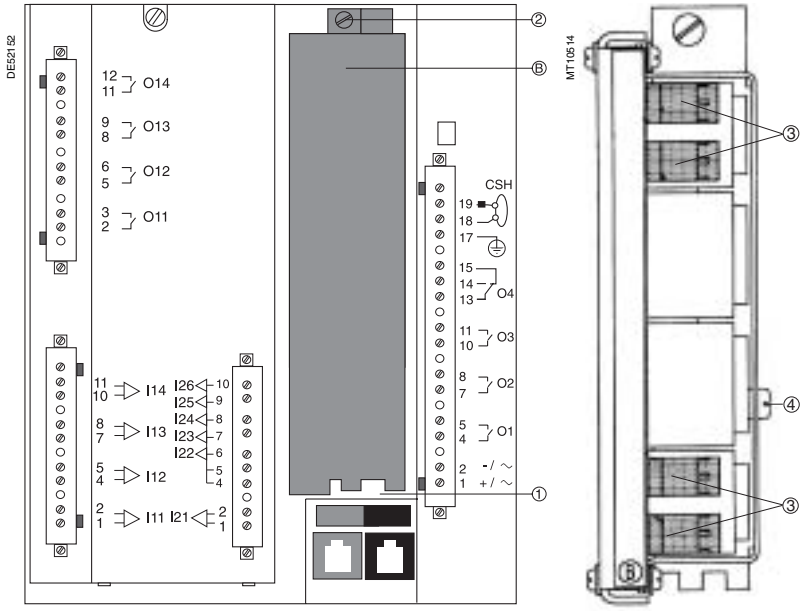
(1) *1, 2 or 3 VTs (case shown).*

Installation of the CCT640 connector

- insert the 2 connector pins into the slots ① on the base unit
- flatten the connector against the unit to plug it into the 9-pin SUB-D connector (principle similar to that of the MES module)
- tighten the mounting screw ②.

Connection

- the connections are made to the screw type connectors that may be accessed on the rear of the CCT640 (item ③)
- wiring without fitting:
  - 1 wire with maximum cross-section of 0.2 to 2.5 mm² (≥ AWG 24-12) or 2 wires with maximum cross-section of 0.2 to 1 mm² (≥ AWG 24-16)
  - stripped length: 8 to 10 mm
- wiring with fitting:
  - recommended wiring with Telemecanique fitting:
    - DZ5CE015D for 1 wire 1.5 mm²
    - DZ5CE025D for 1 wire 2.5 mm²
    - AZ5DE010D for 2 wires 1 mm²
  - tube length: 8.2 mm
  - stripped length: 8 mm
- the CCT640 must be earthed (by green/yellow wire + ring lug) on the screw ④ (safety in case the CCT640 become unplugged).



MES114 modules

10 input/4 output MES114 module.

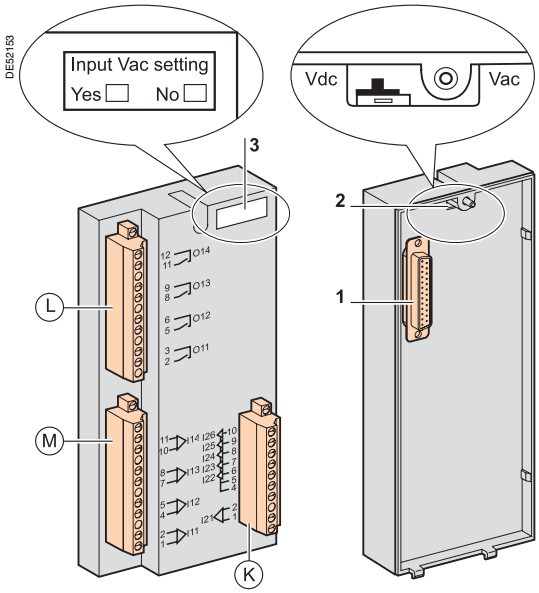
Function

The 4 outputs included on the Sepam series 20 and 40 may be extended by adding an optional MES114 module with 10 inputs and 4 outputs, available in 3 versions:

- MES114: 10 DC inputs voltage from from 24 V DC to 250 V DC
- MES114E: 10 inputs, voltage 110-125 V AC or V DC
- MES114F: 10 inputs, voltage 220-250 V AC or V DC.

Characteristics

MES114 module						
Weight		0.28 kg				
Operating temperature		-25 °C to +70 °C				
Environmental characteristics		Same characteristics as Sepam base units				
Logical inputs		**MES114**	**MES114E**		**MES114F**	
Voltage		24 to 250 V DC	110 to 125 V DC	110 V AC	220 to 250 V DC	220 to 240 V AC
Range		19.2 to 275 V DC	88 to 150 VV DC	88 to 132 V AC	176 to 275 V DC	176 to 264 V AC
Frequency		/	/	47 to 63 Hz	/	47 to 63 Hz
Typical consumption		3 mA	3 mA	3 mA	3 mA	3 mA
Typical switching threshold		14 V DC	82 V DC	58 V AC	154 V DC	120 V AC
Input limit voltage	At state 0	⩾ 19 V DC	⩾ 88 V DC	⩾ 88 V AC	⩾ 176 V DC	⩾ 176 V AC
	At state 1	⩽ 6 V DC	⩽ 75 V DC	⩽ 22 V AC	⩽ 137 V DC	⩽ 48 V AC
O11 control relay output						
Voltage		DC	24 / 48 V DC	127 V DC	220 V DC	
		AC (47.5 to 63 Hz)				100 to 240 V AC
Continuous current			8 A	8 A	8 A	8 A
Breaking capacity		Resistive load	8 / 4 A	0.7 A	0.3 A	8 A
		Load L/R < 20 ms	6 / 2 A	0.5 A	0.2 A	
		Load L/R < 40 ms	4 / 1 A	0.2 A	0.1 A	
		Load cos φ > 0.3				5 A
Making capacity			< 15 A for 200 ms			
O12 to O14 indication relay output						
Voltage		DC	24 / 48 V DC	127 V DC	220 V DC	
		AC (47.5 to 63 Hz)				100 to 240 V AC
Continuous current			2 A	2 A	2 A	2 A
Breaking capacity		Load L/R < 20 ms	2 / 1 A	0.5 A	0.15 A	
		Load cos φ > 0.3				1 A
Making capacity			< 15 A for 200 ms			



Description

Ⓛ, Ⓜ and Ⓚ: 3 removable, lockable screw-type connectors.
Ⓛ: connectors for 4 relay outputs:
- O11: 1 control relay output
- O12 to O14: 3 indication relay outputs.

Ⓜ: connectors for 4 independent logic inputs I11 to I14
Ⓚ: connectors for 6 logic inputs:
- I21: 1 independent logic input
- I22 to I26: 5 common point logic inputs.

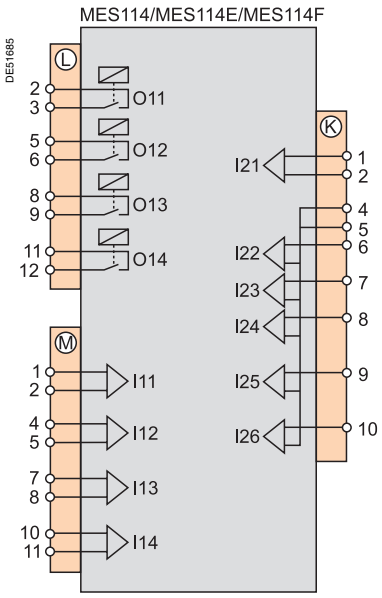
1: 25-pin sub-D connector to connect the module to the base unit
2: voltage selector switche for MES114E and MES114F module inputs, to be set to:
- ☐ V DC for 10 DC voltage inputs (default setting)
- ☐ V AC for 10 AC voltage inputs.

3: label to be filled in to indicate the chosen parameter setting for MES114E and MES114F input voltages.

The parameter setting status may be accessed in the "Sepam Diagnosis" screen of the SFT2841 software tool.
Parameter setting of the inputs for AC voltage (V AC setting) inhibits the "operating time measurement" function.

Assembly

- insert the 2 pins on the MES module into the slots **1** on the base unit
- flatten the module up against the base unit to plug it into the connector **2**
- tighten the **3** mounting screws.



Connection

Dangerous voltages may be present on the terminal screws, whether the terminals are used or not. To avoid all danger of electrical shock, tighten all terminal screws so that they cannot be touched inadvertently.
The inputs are potential-free and the DC power supply source is external.

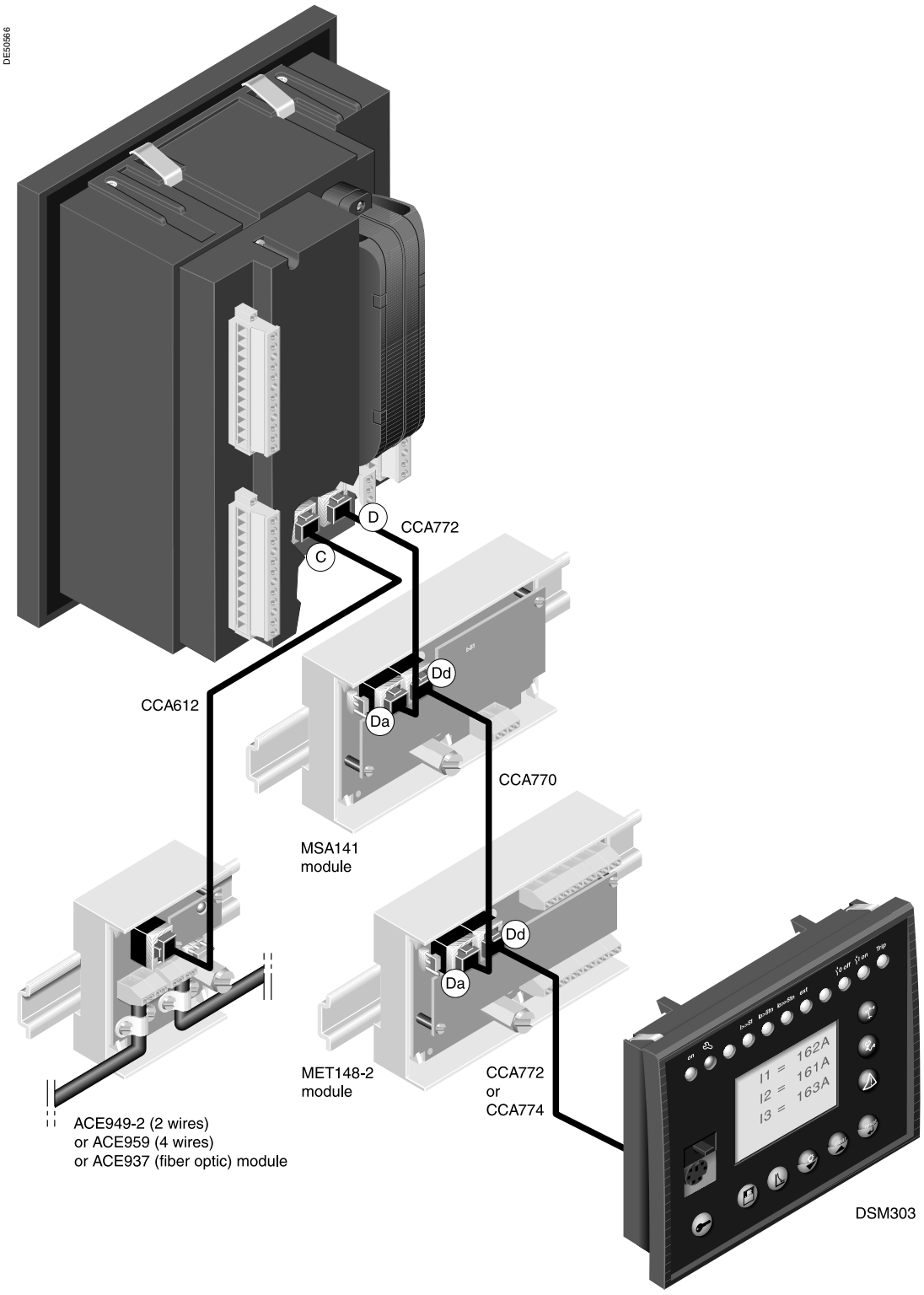
Wiring of connectors Ⓛ, Ⓜ and Ⓚ:
- wiring without fitting:
  - ☐ 1 wire with maximum cross-section 0.2 to 2.5 mm² (> AWG 24-12)
  - ☐ or 2 wires with maximum cross-section 0.2 to 1 mm² (> AWG 24-16)
  - ☐ stripped length: 8 to 10 mm
- wiring with fittings:
  - ☐ recommended wiring with Telemecanique fitting:
    - DZ5CE015D for one 1.5 mm² wire
    - DZ5CE025D for one 2.5 mm² wire
    - AZ5DE010D for two 1 mm² wires
  - ☐ tube length: 8.2 mm
  - ☐ stripped length: 8 mm.

Optional remote modules
Connection

The optional MET148-2, MSA141 or DSM303 modules are connected to the base unit connector Ⓓ by a series of links using prefabricated cords which come in 3 different lengths with black fittings.

- CCA770 (L = 0.6 m)
- CCA772 (L = 2 m)
- CCA774 (L = 4 m).

The DSM303 module may only be connected at the end of the series.
The MSA141 module must be the first one connected to the Sepam unit.
For the configuration that uses the 3 optional modules, comply with the wiring in the diagram below.



MET148-2
Temperature sensor module

MET148-2 temperature sensor module.

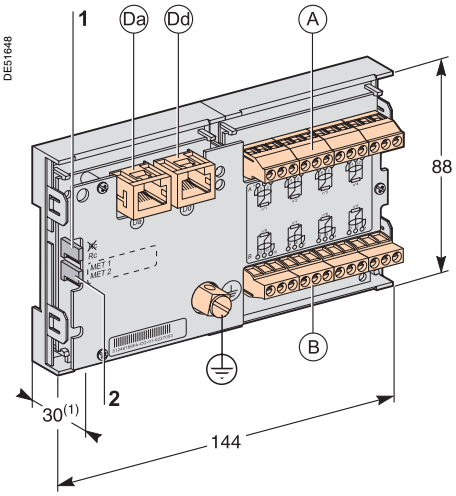
Function

The MET148-2 module may be used to connect 8 temperature sensors (RTDs) of the same type:
- Pt100, Ni100 or Ni120 type RTDs, according to parameter setting
- 3-wire temperature sensors
- a single module for each Sepam series 20 base unit, to be connected by one of the CCA770, CCA772 or CCA774 cords (0.6, 2 or 4 meters))
- 2 modules for each Sepam series 40 or series 80 base unit, to be connected by CCA770, CCA772 or CCA774 cords (0.6, 2 or 4 meters).

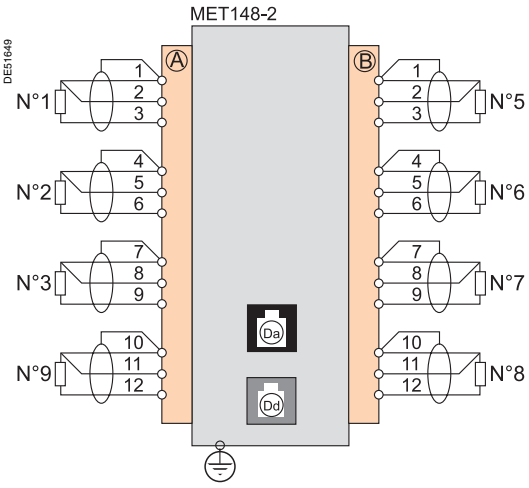
The temperature measurement (e.g. in a transformer or motor winding) is utilized by the following protection functions:
- thermal overload (to take ambient termperature into account)
- temperature monitoring.

Characteristics

MET148-2 module		
Weight	0.2 kg	
Assembly	On symmetrical DIN rail	
Operating temperature	-25 °C to +70 °C	
Environmental characteristics	Same characteristics as Sepam base units	
RTDs	**Pt100**	**Ni100 / Ni120**
Isolation from earth	None	None
Current injected in RTD	4 mA	4 mA



***(1)** 70 mm with CCA77x cord connected.*



Description and dimensions

- (A) Terminal block for RTDs 1 to 4.
- (B) Terminal block for RTDs 5 to 8.
- (Da) RJ45 connector to connect the module to the base unit with a CCA77x cord.
- (Dd) RJ45 connector to link up the next remote module with a CCA77x cord (according to application).
- (⏚) Grounding/earthing terminal.

1 Jumper for impedance matching with load resistor (Rc), to be set to:
- ~~Rc~~, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.

2 Jumper used to select module number, to be set to:
- MET1: 1st MET148-2 module, to measure temperatures T1 to T8 (default position)
- MET2: 2nd MET148-2 module, to measure temperatures T9 to T16 (for Sepam series 40 and series 80 only).

Connection

Connection of the earthing terminal

By tinned copper braid with cross-section ≥ 6 mm² or cable with cross-section ≥ 2.5 mm² and length ≤ 200 mm, equipped with a 4 mm ring lug. Check the tightness (maximum tightening torque 2.2 Nm).

Connection of RTDs to screw-type connectors
- 1 wire with cross-section 0.2 to 2.5 mm² (≥ AWG 24-12)
- or 2 wires with cross-section 0.2 to 1 mm² (≥ AWG 24-16).

Recommended cross-sections according to distance:
- up to 100 m ≥ 1 mm², AWG 16
- up to 300 m ≥ 1.5 mm², AWG 14
- up to 1 km ≥ 2.5 mm², AWG 12.

Maximum distance between sensor and module: 1 km.

Wiring precautions
- it is preferable to use shielded cables

The use of unshielded cables may cause measurement errors, which vary in degree on the level of surrounding electromagnetic disturbance
- only connect the shielding at the MET148-2 end, in the shortest manner possible, to the corresponding terminals of connectors (A) and (B)
- do not connect the shielding at the RTD end.

Accuracy derating according to wiring

The error Δt is proportional to the length of the cable and inversely proportional to the cable cross-section:

$$\Delta t(°C) = 2 \times \frac{L(km)}{S(mm^2)}$$

- ±2.1 °C/km for 0.93 mm² cross-section
- ±1 °C/km for 1.92 mm² cross-section.

MSA141
Analog output module

MSA141 analog output module.

Function

The MSA141 module converts one of the Sepam measurements into an analog signal:
- selection of the measurement to be converted by parameter setting
- 0-10 mA, 4-20 mA, 0-20 mA analog signal according to parameter setting
- scaling of the analog signal by setting minimum and maximum values of the converted measurement.

Example: the setting used to have phase current 1 as a 0-10 mA analog output with a dynamic range of 0 to 300 A is:
- minimum value = 0
- maximum value = 3000

- a single module for each Sepam base unit, to be connected by one of the CCA770, CCA772 or CCA774 cords (0.6, 2 or 4 meters).

The analog output may also be remotely managed via the communication network.

Characteristics

MSA141 module	
Weight	0.2 kg
Assembly	On symmetrical DIN rail
Operating temperature	-25 °C to +70 °C
Environmental characteristics	Same characteristics as Sepam base units

Analog output	
Current	4-20 mA, 0-20 mA, 0-10 mA
Scaling (no data input checking)	Minimum value
	Maximum value
Load impedance	< 600 Ω (wiring included)
Accuracy	0.5 %

Measurements available	Unit	Series 20	Series 40	Series 80
Phase and residual currents	0.1 A	■	■	■
Phase-to-neutral and phase-to-phase voltages	1 V	■	■	■
Frequency	0.01 Hz	■	■	■
Thermal capacity used	1 %	■	■	■
Temperatures	1°C	■	■	■
Active power	0.1 kW		■	■
Reactive power	0.1 kVAR		■	■
Apparent power	0.1 kVA		■	■
Power factor	0.01			■
Remote setting via communication link		■	■	■

Description and dimensions

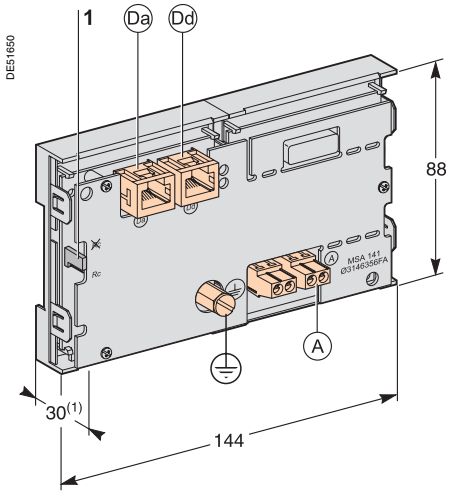
Ⓐ Terminal block for analog output.

Ⓓa RJ45 connector to connect the module to the base unit with a CCA77x cord.

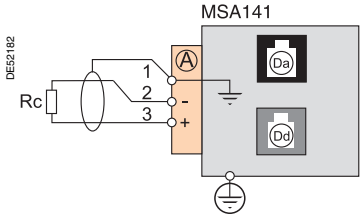
Ⓓd RJ45 connector to link up the next remote module with a CCA77x cord (according to application).

⏚ Grounding/earthing terminal.

1 Jumper for impedance matching with load resistor (Rc), to be set to:
- ~~Rc~~, if the module is not the last interlinked module (default position)
- Rc, if the module is the last interlinked module.



***(1)** 70 mm with CCA77x cord connected.*



Connection

Earthing terminal connection

By tinned copper braid with cross-section ≥ 6 mm² or cable with cross-section ≥ 2.5 mm² and length ≤ 200 mm, equipped with a 4 mm ring lug. Check the tightness (maximum tightening torque 2.2 Nm).

Connection of analog output to screw-type connector
- 1 wire with cross-section 0.2 to 2.5 mm² (≥ AWG 24-12)
- or 2 wires with cross-section 0.2 to 1 mm² (≥ AWG 24-16).

Wiring precautions
- it is preferable to use shielded cables
- use tinned copper braid to connect the shielding at least at the MSA141 end.

DSM303
Remote advanced UMI module

PE50127

DSM303 remote advanced UMI module.

Function

When associated with a Sepam that does not have its own advanced user-machine interface, the DSM303 offers all the functions available on a Sepam integrated advanced UMI.
It may be installed on the front panel of the cubicle in the most suitable operating location:

- reduced depth (< 30 mm)
- a single module for each Sepam, to be connected by one of the CCA772 or CCA774 cords (2 or 4 meters).

The module may not be connected to Sepam units with integrated advanced UMIs.

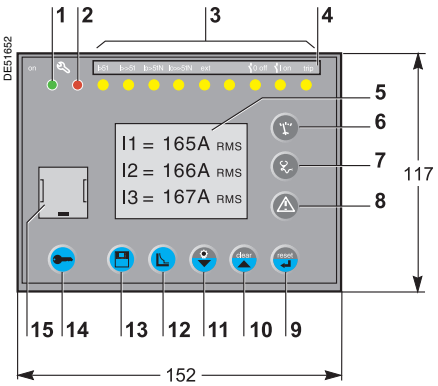
Characteristics

DSM303 module	
Weight	0.3 kg
Assembly	Flush-mounted
Operating temperature	-25 °C to +70 °C
Environmental characteristics	Same characteristics as Sepam base units

Description and dimensions

The module is flush-mounted and secured simply by its clips. No screw-type fastener is required.

DE51652

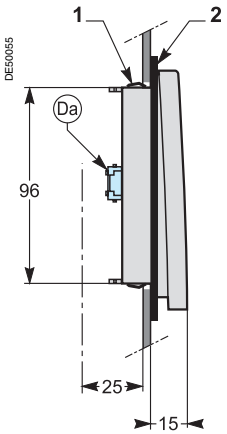


1 Green LED: Sepam on.
2 Red LED:
- steadily on: module unavailable
- flashing: Sepam link unavailable.

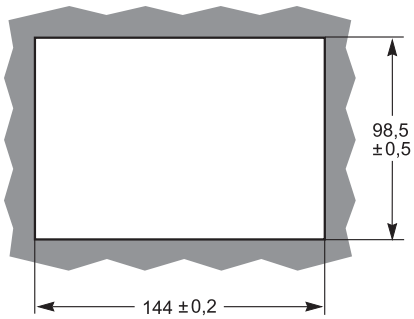
3 9 yellow indication LEDs.
4 Label identifying the indication LEDs.
5 Graphical LCD screen.
6 Display of measurements.
7 Display of switchgear, network and machine diagnosis data.
8 Display of alarm messages.
9 Sepam reset (or confirm data entry).
10 Alarm acknowledgement and clearing (or move cursor up).
11 LED test (or move cursor down).
12 Access to protection settings.
13 Access to Sepam parameters.
14 Entry of 2 passwords.
15 PC connection port.

Side view

DE50055



Cut-out for flush-mounting (mounting plate thickness < 3 mm)



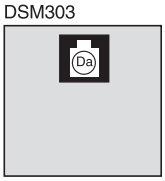
(Da) RJ45 lateral output connector to connect the module to the base unit with a CCA77x cord.

1 Mounting clip.
2 Gasket to ensure NEMA 12 tightness (gasket delivered with the DSM303 module, to be installed if necessary).

Connection

DSM303

MT10151



(Da) RJ45 connector to connect the module to the base unit with a CCA77x cord.
The DSM303 module is always the last interlinked remote module and it systematically ensures impedance matching by load resistor (Rc).

Communication accessories selection guide

There are 2 types of Sepam communication accessories:
■ communication interfaces, which are essential for connecting Sepam to the communication network
■ converters and other accessories, as options, which are used for complete implementation of the communication network.

Communication-interface selection guide

		ACE949-2	ACE959	ACE937	ACE969TP		ACE969FO	
Type of network								
		S-LAN or E-LAN (1)	S-LAN or E-LAN (1)	S-LAN or E-LAN (1)	S-LAN	E-LAN	S-LAN	E-LAN
Protocol								
Modbus		■	■	■	■	■	■	■
DNP3					■		■	
IEC 60870-5-103					■		■	
Physical interface								
RS 485	2-wire	■			■	■		■
	4-wire		■					
Fiber optic ST	Star			■			■	
	Ring						■ (2)	
See details on page		**6/27**	**6/28**	**6/29**	**6/30**		**6/30**	

(1) *Only one connection possible, S-LAN or E-LAN.*
(2) *Except with the Modbus protocol.*

Converter selection guide

	ACE909-2	ACE919CA	ACE919CC	EGX200	EGX400
Converter					
Port to supervisor	1 RS232 port	1 2-wire RS 485 port	1 2-wire RS 485 port	1 Ethernet port 10/100 base Tx	1 Ethernet port 10/100 base Tx and 1 Ethernet port 100 base Fx
Port to Sepam	1 2-wire RS 485 port	1 2-wire RS 485 port	1 2-wire RS 485 port	2 2-wire or 4-wire RS485 ports	2 2-wire RS 485 or 4-wire RS485 ports
Distributed power supply RS485	Supplied by ACE	Supplied by ACE	Supplied by ACE	Not supplied by EGX	Not supplied by EGX
Protocol					
Modbus	■	■	■	■	■
IEC 60870-5-103	■	■	■		
DNP3	■	■	■		
Power supply					
DC			24 to 48 V DC	24 V DC	24 V DC
AC	110 to 220 V AC	110 to 220 V AC		100 to 240 V AC (with adapter)	100 to 240 V AC (with adapter)
See details on page	**6/34**	**6/36**	**6/36**	**See EGX200 manual**	**See EGX400 manual**

6

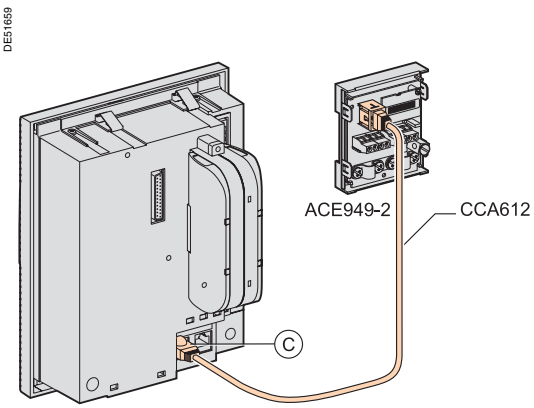
Communication interface connection

CCA612 connection cord

Cord used to connect a communication interface to a Sepam base unit:
- length = 3 m
- fitted with 2 green RJ45 plugs.

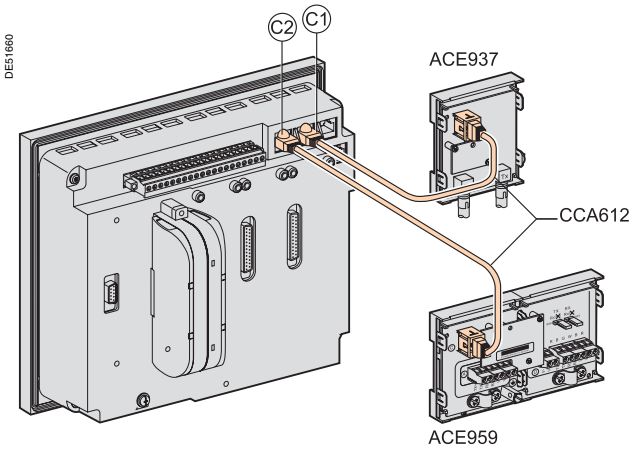
Sepam / communication interface connection

Sepam series 20 and Sepam series 40



Sepam series 20 and Sepam series 40: 1 communication port.

Sepam series 80



Sepam series 80: 2 communication ports.

RS 485 network cable

RS 485 network cable	2-wire	4-wire
RS 485 medium	1 shielded twisted pair	2 shielded twisted pairs
Distributed power supply	1 shielded twisted pair	1 shielded twisted pair
Shielding	Tinned copper braid, coverage > 65 %	
Characteristic impedance	120 Ω	
Gauge	AWG 24	
Resistance per unit length	< 100 Ω/km	
Capacitance between conductors	< 60 pF/m	
Capacitance between conductor and shielding	< 100 pF/m	
Maximum length	1300 m	

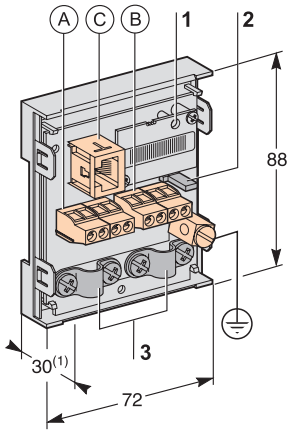
Fiber optic				
Fiber type	Multimode glass			
Wavelength	820 nm (infra-red)			
Type of connector	ST (BFOC bayonet fiber optic connector)			
Fiber optic diameter (µm)	**Numerical aperture (NA)**	**Maximum attenuation (dBm/km)**	**Minimum optical power available (dBm)**	**Maximum length of fiber (m)**
50/125	0.2	2.7	5.6	700
62.5/125	0.275	3.2	9.4	1800
100/140	0.3	4	14.9	2800
200 (HCS)	0.37	6	19.2	2600

ACE949-2
2-wire RS 485 network interface

PE50029

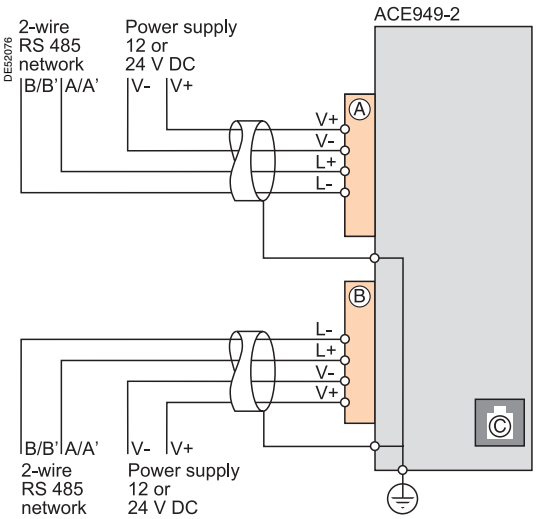
ACE949-2 2-wire RS 485 network connection interface.

DE51661



***(1)** 70 mm with CCA612 cord connected.*

DE52076



Function

The ACE949-2 interface performs 2 functions:
- electrical interface between Sepam and a 2-wire RS 485 communication network
- main network cable branching box for the connection of a Sepam with a CCA612 cord.

Characteristics

ACE949-2 module	
Weight	0.1 kg
Assembly	On symmetrical DIN rail
Operating temperature	-25 °C to +70 °C
Environmental characteristics	Same characteristics as Sepam base units
2-wire RS 485 electrical interface	
Standard	EIA 2-wire RS 485 differential
Distributed power supply	External, 12 V DC or 24 V DC ±10 %
Consumption	16 mA in receiving mode
	40 mA maximum in sending mode

Maximum length of 2-wire RS 485 network with standard cable

Number of Sepam units	Maximum length with 12 V DC power supply	Maximum length with 24 V DC power supply
5	320 m	1000 m
10	180 m	750 m
20	160 m	450 m
25	125 m	375 m

Description and dimensions

(A) and (B) Terminal blocks for network cable.

(C) RJ45 plug to connect the interface to the base unit with a CCA612 cord.

⏚ Grounding/earthing terminal.

1 Link activity LED, flashes when communication is active (sending or receiving in progress).

2 Jumper for RS 485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ~~Rc~~, if the module is not at one end of the RS 485 network (default position)
- Rc, if the module is at one end of the RS 485 network.

3 Network cable clamps (inner diameter of clamp = 6 mm).

Connection

- connection of network cable to screw-type terminal blocks (A) and (B)
- connection of earthing terminal by tinned copper braid with cross-section ≥ 6 mm² or cable with cross-section ≥ 2.5 mm² and length ≤ 200 mm, equipped with a 4 mm ring lug.

Check the tightness (maximum tightening torque 2.2 Nm).
- the interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - ☐ the network cable must be stripped
  - ☐ the cable shielding braid must be around and in contact with the clamp
- the interface is to be connected to connector (C) on the base unit using a CCA612 cord (length = 3 m, green fittings)
- the interfaces are to be supplied with 12 V DC or 24 V DC.

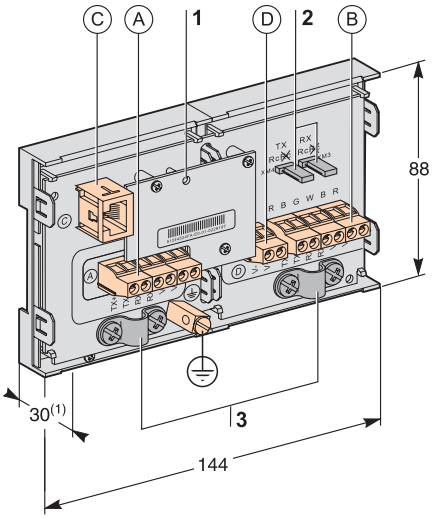
6

ACE959
4-wire RS 485 network interface

PE50023

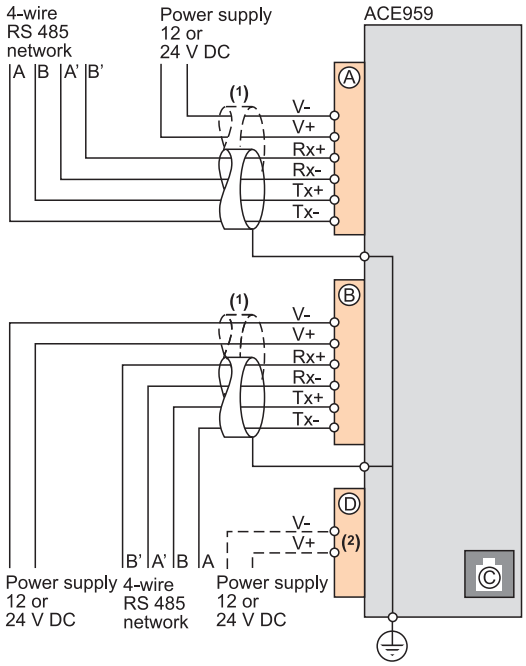
ACE959 4-wire RS 485 network connection interface.

DE51663



***(1)** 70 mm with CCA612 cord connected.*

DE52077



***(1)** Distributed power supply with separate wiring or included in the shielded cable (3 pairs).*
***(2)** Terminal block for connection of the distributed power supply module.*

Function

The ACE959 interface performs 2 functions:
- electrical interface between Sepam and a 4-wire RS 485 communication network
- main network cable branching box for the connection of a Sepam with a CCA612 cord.

Characteristics

ACE959 module	
Weight	0.2 kg
Assembly	On symmetrical DIN rail
Operating temperature	-25 °C to +70 °C
Environmental characteristics	Same characteristics as Sepam base units

4-wire RS 485 electrical interface	
Standard	EIA 4-wire RS 485 differential
Distributed power supply	External, 12 V DC or 24 V DC ±10 %
Consumption	16 mA in receiving mode
	40 mA maximum in sending mode

Maximum length of 4-wire RS 485 network with standard cable

Number of Sepam units	Maximum length with 12 V DC power supply	Maximum length with 24 V DC power supply
5	320 m	1000 m
10	180 m	750 m
20	160 m	450 m
25	125 m	375 m

Description and dimensions

(A) and (B) Terminal blocks for network cable.

(C) RJ45 plug to connect the interface to the base unit with a CCA612 cord.

(D) Terminal block for a separate auxiliary power supply (12 V DC or 24 V DC).

(⏚) Grounding/earthing terminal.

1 Link activity LED, flashes when communication is active (sending or receiving in progress).
2 Jumper for RS 485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
   - ■ ~~Rc~~, if the module is not at one end of the RS 485 network (default position)
   - ■ Rc, if the module is at one end of the RS 485 network.
3 Network cable clamps (inner diameter of clamp = 6 mm).

Connection

- ■ connection of network cable to screw-type terminal blocks (A) and (B)
- ■ connection of earthing terminal by tinned copper braid with cross-section ⩾ 6 mm² or cable with cross-section ⩾ 2.5 mm² and length ⩽ 200 mm, equipped with a 4 mm ring lug.

Check the tightness (maximum tightening torque 2.2 Nm).

- ■ the interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
  - □ the network cable must be stripped
  - □ the cable shielding braid must be around and in contact with the clamp
- ■ the interface is to be connected to connector (C) on the base unit using a CCA612 cord (length = 3 m, green fittings)
- ■ the interfaces are to be supplied with 12 V DC or 24 V DC
- ■ the ACE959 can be connected to a separate distributed power supply (not included in shielded cable). Terminal block (D) is used to connect the distributed power supply module.

ACE937
Fiber optic interface

PE50024

ACE937 fiber optic connection interface.

Function

The ACE937 interface is used to connect Sepam to a fiber optic communication star system.
This remote module is connected to the Sepam base unit by a CCA612 cord.

Characteristics

ACE937 module	
Weight	0.1 kg
Assembly	On symmetrical DIN rail
Power supply	Supplied by Sepam
Operating temperature	-25 °C to +70 °C
Environmental characteristics	Same characteristics as Sepam base units

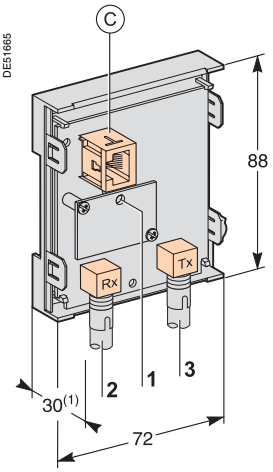
Fiber optic interface	
Fiber type	Multimode glass
Wavelength	820 nm (infra-red)
Type of connector	ST (BFOC bayonet fiber optic connector)

Fiber optic diameter (µm)	Numerical aperture (NA)	Maximum attenuation (dBm/km)	Minimum optical power available (dBm)	Maximum length of fiber (m)
50/125	0.2	2.7	5.6	700
62.5/125	0.275	3.2	9.4	1800
100/140	0.3	4	14.9	2800
200 (HCS)	0.37	6	19.2	2600

Maximum length calculated with:
- minimum optical power available
- maximum fiber attenuation
- losses in 2 ST connectors: 0.6 dBm
- optical power margin: 3 dBm (according to IEC 60870 standard).

Example for a 62.5/125 µm fiber
Lmax = (9.4 - 3 -0.6) / 3.2 = 1.8 km.

DE51665



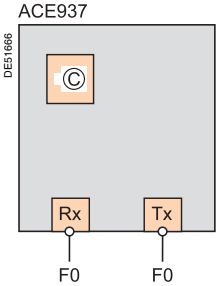
(1) *70 mm with CCA612 cord connected.*

Description and dimensions

(C) RJ45 plug to connect the interface to the base unit with a CCA612 cord.

1 Link activity LED, flashes when communication is active (sending or receiving in progress).
2 Rx, female ST type connector (Sepam receiving).
3 Tx, female ST type connector (Sepam sending).

DE51666



Connection

- the sending and receiving fiber optics fibers must be equipped with male ST type connectors
- fiber optics screw-locked to Rx and Tx connectors
- the interface is to be connected to connector (C) on the base unit using a CCA612 cord (length = 3 m, green fittings)

ACE969TP and ACE969FO Multi-protocol interfaces

PE50470

ACE969TP communication interface.

PE50471

ACE969FO communication interface.

Function

The ACE969 multi-protocol communication interfaces are for Sepam series 20, 40 and 80.
They have two communication ports to connect a Sepam to two independent communication networks:
■ the S-LAN (supervisory local area network) port to connect Sepam to a supervision network using one of the three following protocols:
□ IEC 60870-5-103
□ DNP3
□ RTU Modbus.
The communication protocol is selected at the time of Sepam parameter setting.
■ the E-LAN (engineering local area network) port, reserved for Sepam remote parameter setting and operation using the SFT2841 software.

There are two versions of the ACE969 interfaces that have different S-LAN ports:
■ ACE969TP (Twisted Pair), for connection to an S-LAN network using a two-wire RS485 connection
■ ACE969FO (Fiber Optic), for connection to an S-LAN network using a fiber-optic connection (star or ring).
The E-LAN port is always a two-wire RS485 connection.

ACE969TP and ACE969FO Multi-protocol interfaces

Characteristics

ACE969 module

Technical characteristics

Weight	0.285 kg
Assembly	On symmetrical DIN rail
Power supply	-25 °C to +70 °C
Operating temperature	Same characteristics as Sepam base units

Power supply

Voltage	24 to 250 V DC	110 to 240 V AC
Range	-20 % / +10 %	-20 % / +10 %
Maximum consumption	2 W	3 VA
Inrush current	< 10 A 100 µs	
Acceptable ripple content	12 %	
Acceptable momentary outages	20 ms	

2-wire RS485 communication ports

Electrical interface

Standard	EIA 4-wire RS 485 differential
Distributed power supply	External, 12 V DC or 24 V DC ±10 %
Consumptionn	16 mA in receiving mode
	40 mA in sending mode
Max. number of Sepam units	25

Maximum length of 2-wire RS 485 network

Number of Sepam units	With distributed power supply	
	12 V DC	24 V DC
5	320 m	1000 m
10	180 m	750 m
20	130 m	450 m
25	125 m	375 m

Fiber-optic communication port

Fiber optic interface

Fiber type	Multimode glass
Wavelength	820 nm (infra-red)
Type of connector	ST (BFOC bayonet fiber optic connector)

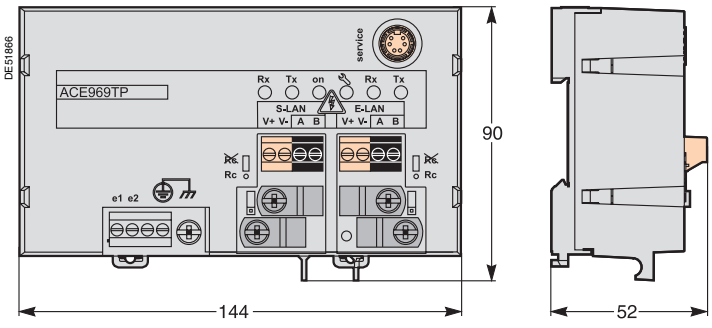
Maximum length of fiber-optic network

Fiber diameter (µm)	Numerical aperture (NA)	Attenuation (dBm/km)	Minimum optical power available (dBm)	Maximum fiber length (m)
50/125	0.2	2.7	5.6	700
62.5/125	0.275	3.2	9.4	1800
100/140	0.3	4	14.9	2800
200 (HCS)	0.37	6	19.2	2600

Maximum length calculated with:
- minimum optical power available
- maximum fiber attenuation
- losses in 2 ST connectors: 0.6 dBm
- optical power margin: 3 dBm (according to IEC60870 standard).

Example for a 62.5/125 µm fiber
Lmax = (9.4 - 3 -0.6) / 3.2 = 1.8 km.

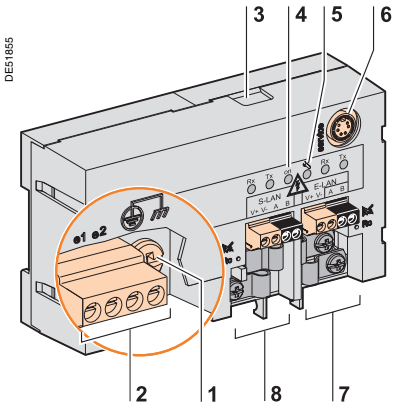
Dimensions



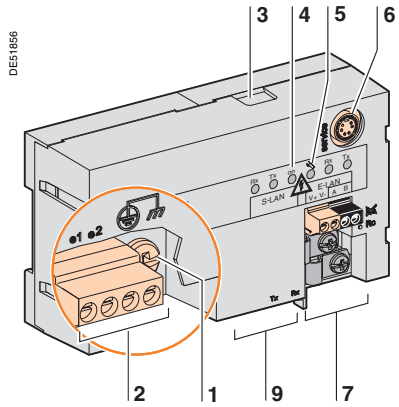
ACE969TP and ACE969FO Multi-protocol interfaces
Description

ACE969 communication interfaces

ACE969TP



ACE969FO

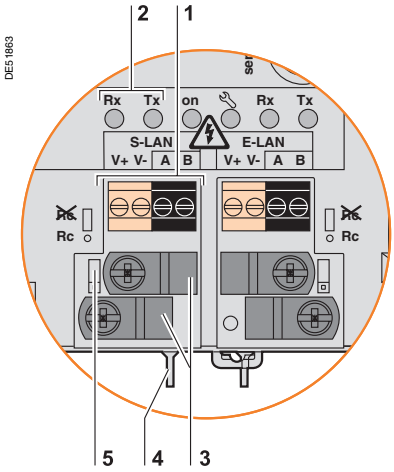


1 Grounding/earthing terminal using supplied braid
2 Power-supply terminal block
3 RJ45 connector to connect the interface to the base unit with a CCA612 cord
4 Green LED: ACE969 energized
5 Red LED: ACE969 interface status
- ■ LED off = ACE969 set up and communication operational
- ■ LED flashing = ACE969 not set up or setup incorrect
- ■ LED remains on = ACE969 has faulted

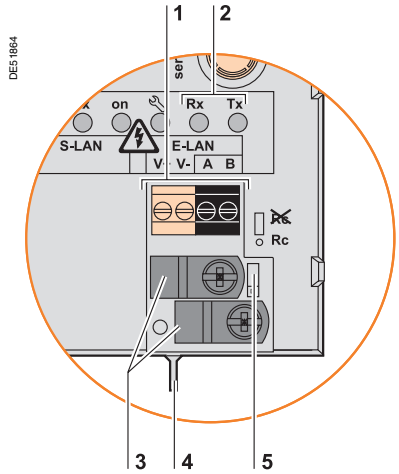
6 Service connector: reserved for software upgrades
7 E-LAN 2-wire RS485 communication port (ACE969TP and ACE969FO)
8 S-LAN 2-wire RS485 communication port (ACE969TP)
9 S-LAN fiber-optic communication port (ACE969FO).

2-wire RS485 communication ports

Port S-LAN (ACE969TP)



Port E-LAN (ACE969TP or ACE969FO)



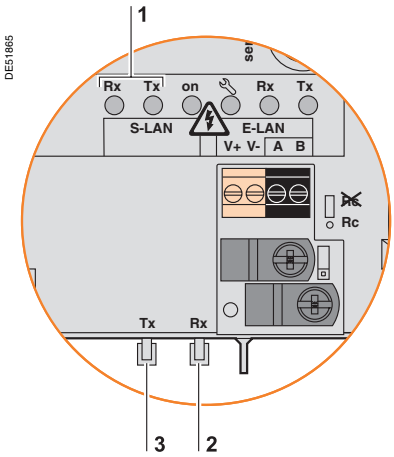
1 2-wire RS485 network terminal block:
- ■ 2 black terminals: connection of RS485 twisted-pair (2 wires)
- ■ 2 green terminals: connection of twisted-pair for distributed power supply

2 Indication LEDs:
- ■ flashing Tx LED: Sepam sending
- ■ flashing Rx LED: Sepam receiving.

3 Clamps and recovery of shielding for two network cables, incoming and outgoing (inner diameter of clamp = 6 mm)
4 Fixing stud for network cable ties
5 Jumper for RS485 network line-end impedance matching with load resistor (Rc = 150 Ω), to be set to:
- ■ ~~Rc~~, if the interface is not at the line end (default position)
- ■ Rc, if the interface is at the line end.

Fiber-optic communication port

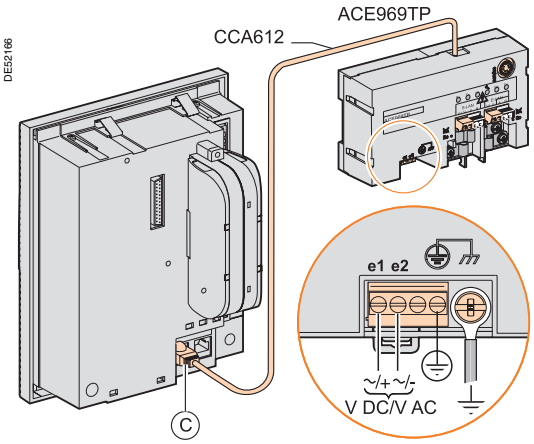
Port S-LAN (ACE969FO)



1 Indication LEDs:
- ■ flashing Tx LED: Sepam sending
- ■ flashing Rx LED: Sepam receiving.

2 Rx, female ST-type connector (Sepam receiving)
3 Tx, female ST-type connector (Sepam sending).

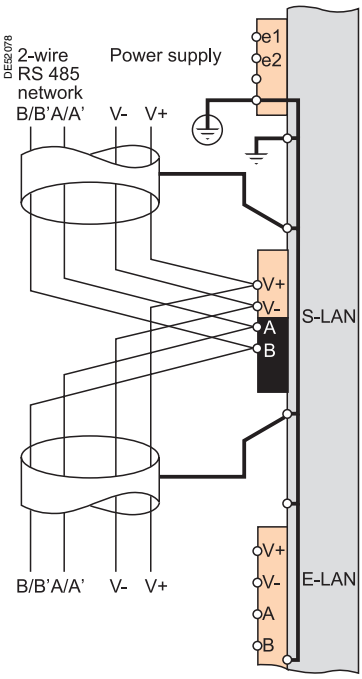
ACE969TP and ACE969FO Multi-protocol interfaces
Connection



Power supply and Sepam

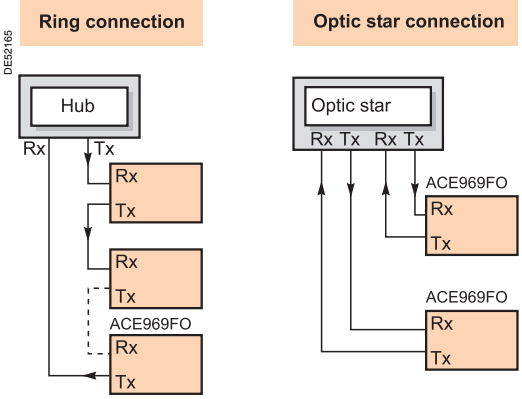
■ the ACE969 interface connects to connector C on the Sepam base unit using a CCA612 cord (length = 3 m, green RJ45 fittings)
■ the ACE969 interface must be supplied with 24 to 250 V DC or 110 to 230 V AC.

Terminals	Type	Wiring
e1-e2 - supply	Screw terminals	■ wiring without fittings: □ 1 wire with max. cross-section 0.2 to 2.5 mm² (≥ AWG 24-12) or 2 wires with max. cross-section 0.2 to 1 mm² (≥ AWG 24-16) □ stripped length: 8 to 10 mm ■ wiring with fittings: □ recommended wiring with Telemecanique fittings: - DZ5CE015D for 1 wire 1.5 mm² - DZ5CE025D for 1 wire 2.5 mm² - AZ5DE010D for 2 x 1 mm² wires □ tube length: 8.2 mm □ stripped length: 8 mm
DE51962 Protective earth	Screw terminal	1 green/yellow wire, max. length 3 m and max. cross-section 2.5 mm²
DE51845 Functional earth	4 mm ring lugs	Earthing braid, supplied for connection to cubicle grounding



2-wire RS485 communication ports (S-LAN or E-LAN)

■ connection of RS485 twisted-pair (S-LAN or E-LAN) to black terminals A and B
■ connection of twisted-pair for distributed power supply to green terminals V+ and V-
■ the interfaces are fitted with clamps to hold the network cable and recover shielding at the incoming and outgoing points of the network cable:
□ the network cable must be stripped
□ the cable shielding must be rolled back and in contact with the clamp
□ shielding continuity of incoming and outgoing cables is ensured by the electrical continuity of the clamps
■ all cable clamps are linked by an internal connection to the earthing terminals of the ACE969 interface (protective and functional earthing), i.e. the shielding of the RS485 cables is earthed as well
■ on the ACE969TP interface, the cable clamps for the S-LAN and E-LAN RS485 networks are earthed.



Fiber-optic communication port (S-LAN)

The fiber-optic connection can be made:
■ point-to-point to an optic star system
■ in a ring system (active echo).
The sending and receiving fiber optics fibers must be equipped with male ST type connectors.
The fiber optics are screw-locked to Rx and Tx connectors.

ACE909-2
RS 232 / RS 485 converter

PE50035

ACE909-2 RS 232 / RS 485 converter.

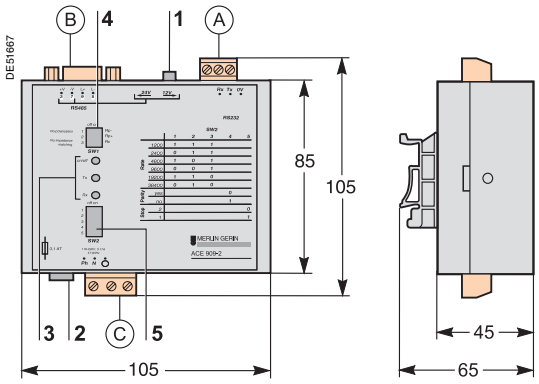
Function

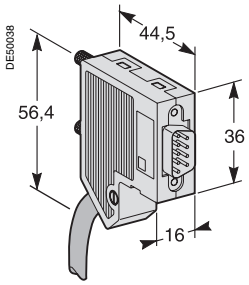
The ACE909-2 converter is used to connect a master/central computer equipped with a V24/RS 232 type serial port as a standard feature to stations connected to a 2-wire RS 485 network.
Without requiring any flow control signals, after the parameters are set, the ACE909-2 converter performs conversion, network polarization and automatic dispatching of frames between the master and the stations by two-way simplex (half-duplex, single-pair) transmission.
The ACE909-2 converter also provides a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam ACE949-2, ACE959 or ACE969 interfaces.
The communication settings should be the same as the Sepam and master communication settings.

Characteristics

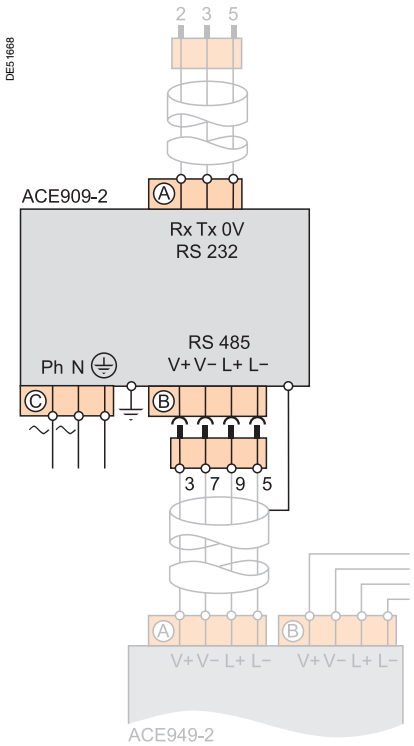
Mechanical characteristics		
Weight	0.280 kg	
Assembly	On symmetrical or asymmetrical DIN rail	
Electrical characteristics		
Power supply	110 to 220 V AC ±10 %, 47 to 63 Hz	
Galvanic isolation between power supply and frame, and between power supply and interface supply	2000 Vrms, 50 Hz, 1 min	
Galvanic isolation between RS 232 and RS 485 interfaces	1000 Vrms, 50 Hz, 1 min	
Protection by time-delayed fuse 5 mm x 20 mm	1 A rating	
Communication and Sepam interface distributed supply		
Data format	11 bits: 1 start, 8 bits, 1 parity, 1 stop	
Transmission delay	< 100 ns	
distributed power supply for Sepam interfaces	12 V DC or 24 V DC	
Maximum number of Sepam interfaces with distributed supply	12	
Environmental characteristics		
Operating temperature	-5 °C to +55 °C	
Electromagnetic compatibility	**IEC standard**	**Value**
5 ns fast transient bursts	60255-22-4	4 kV with capacitive coupling in common mode 2 kV with direct coupling in common mode 1 kV with direct coupling in differential mode
1 MHz damped oscillating wave	60255-22-1	1 kV common mode 0.5 kV differential mode
1.2 / 50 µs impulse wave	60255-5	3 kV common mode 1 kV differential mode

ACE909-2
RS 232 / RS 485 converter





Male 9-pin sub-D connector supplied with the ACE909-2.



Description and dimensions

(A) Terminal block for RS 232 link limited to 10 m.

(B) Female 9-pin sub-D connector to connect to the 2-wire RS 485 network, with distributed power supply.

1 screw-type male 9-pin sub-D connector is supplied with the converter.

(C) Power supply terminal block.

1 Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
2 Protection fuse, unlocked by a 1/4 turn.
3 Indication LEDs:
- ON/OFF: on if ACE909-2 is energized
- Tx: on if RS 232 sending by ACE909-2 is active
- Rx on: if RS 232 receiving by ACE909-2 is active

4 SW1, parameter setting of 2-wire RS 485 network polarization and line impedance matching resistors

Function	SW1/1	SW1/2	SW1/3
Polarization at 0 V via Rp -470 Ω	ON		
Polarization at 5 V via Rp +470 Ω		ON	
2-wire RS 485 network impedance matching by 150 Ω resistor			ON

5 SW2, parameter setting of asynchronous data transmission rate and format (same parameters as for RS 232 link and 2-wire RS 485 network).

Rate (bauds)	SW2/1	SW2/2	SW2/3		
1200	1	1	1		
2400	0	1	1		
4800	1	0	1		
9600	0	0	1		
19200	1	1	0		
38400	0	1	0		
Format				**SW2/4**	**SW2/5**
With parity check				0	
Without parity check				1	
1 stop bit (compulsory for Sepam)					0
2 stop bits					1

Converter configuration when delivered
- 12 V DC distributed power supply
- 11 bit format, with parity check
- 2-wire RS 485 network polarization and impedance matching resistors activated.

Connection

RS 232 link
- to 2.5 mm² screw-type terminal block (A)
- maximum length 10 m
- Rx/Tx: RS 232 receiving/sending by ACE909-2
- 0V: Rx/Tx common, do not earth.

2-wire RS 485 link with distributed power supply
- to female 9-pin sub-D connector (B)
- 2-wire RS 485 signals: L+, L-
- distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

Power supply
- to 2.5 mm² screw-type terminal block (C)
- reversible phase and neutral
- earthed via terminal block and metal case (ring lug on back of case).

ACE919CA and ACE919CC RS 485 / RS 485 converters

PE50036

ACE919CC RS 485 / RS 485 converter.

Function

The ACE919 converters are used to connect a master/central computer equipped with an RS 485 type serial port as a standard feature to stations connected to a 2-wire RS 485 network.
Without requiring any flow control signals, the ACE919 converters perform network polarization and impedance matching.
The ACE919 converters also provide a 12 V DC or 24 V DC supply for the distributed power supply of the Sepam ACE949-, ACE959 or ACE969 interfaces.
There are 2 types of ACE919 converters:

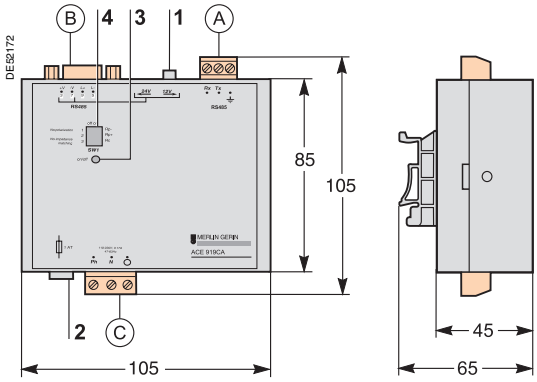
- ACE919CC, DC-powered
- ACE919CA, AC-powered.

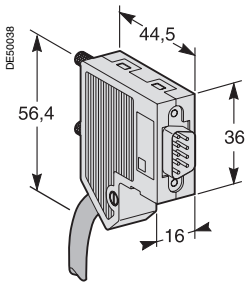
Characteristics

Mechanical characteristics		
Weight	0.280 kg	
Assembly	On symmetrical or asymmetrical DIN rail	
Electrical characteristics	**ACE919CA**	**ACE919CC**
Power supply	110 to 220 V AC ±10 %, 47 to 63 Hz	24 to 48 V DC ±20 %
Protection by time-delayed fuse 5 mm x 20 mm	1 A rating	1 A rating
Galvanic isolation between power supply and frame, and between power supply and interface supply		2000 Vrms, 50 Hz, 1 min
Communication and Sepam interface distributed supply		
Data format	11 bits: 1 start, 8 bits, 1 parity, 1 stop	
Transmission delay	< 100 ns	
Distributed power supply for Sepam interfaces	12 V DC or 24 V DC	
Maximum number of Sepam interfaces with distributed supply	12	
Environmental characteristics		
Operating temperature	-5 °C to +55 °C	

Electromagnetic compatibility	**IEC standard**	**Value**
5 ns fast transient bursts	60255-22-4	4 kV with capacitive coupling in common mode 2 kV with direct coupling in common mode 1 kV with direct coupling in differential mode
1 MHz damped oscillating wave	60255-22-1	1 kV common mode 0.5 kV differential mode
1.2 / 50 µs impulse wave	60255-5	3 kV common mode 1 kV differential mode

ACE919CA and ACE919CC RS 485 / RS 485 converters





Male 9-pin sub-D connector supplied with the ACE919.

Description and dimensions

(A) Terminal block for 2-wire RS 485 link without distributed power supply.

(B) Female 9-pin sub-D connector to connect to the 2-wire RS 485 network, with distributed power supply.

1 screw-type male 9-pin sub-D connector is supplied with the converter.

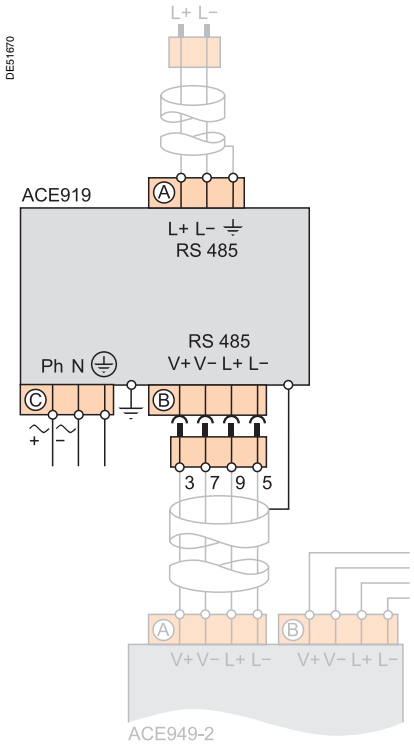
(C) Power supply terminal block.

1 Distributed power supply voltage selector switch, 12 V DC or 24 V DC.
2 Protection fuse, unlocked by a 1/4 turn.
3 ON/OFF LED: on if ACE919 is energized.
4 SW1, parameter setting of 2-wire RS 485 network polarization and impedance matching resistors.

Function	SW1/1	SW1/2	SW1/3
Polarization at 0 V via Rp -470 Ω	ON		
Polarization at 5 V via Rp +470 Ω		ON	
2-wire RS 485 network impedance matching by 150 Ω resistor			ON

Converter configuration when delivered
- 12 V DC distributed power supply
- 2-wire RS 485 network polarization and impedance matching resistors activated.

Connection



2-wire RS 485 link without distributed power supply
- to 2.5 mm² screw-type terminal block (A)
- L+, L-: 2-wire RS 485 signals
- ⏚ Shielding.

2-wire RS 485 link with distributed power supply
- to female 9-pin sub-D connector (B)
- 2-wire RS 485 signals: L+, L-
- distributed power supply: V+ = 12 V DC or 24 V DC, V- = 0 V.

Power supply
- to 2.5 mm² screw-type terminal block (C)
- reversible phase and neutral (ACE919CA)
- earthed via terminal block and metal case (ring lug on back of case).

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User Machine Interfaces

Sepam User Machine Interfaces

Two different levels of user machine interface (UMI) are offered on the front panel of Sepam:

- basic UMI, with signal lamps, for installations operated via a remote system with no need for local operation
- advanced UMI, with keypad and graphic LCD display, giving access to all the information necessary for local operation and Sepam parameter setting.

SFT2841 setting and operating software

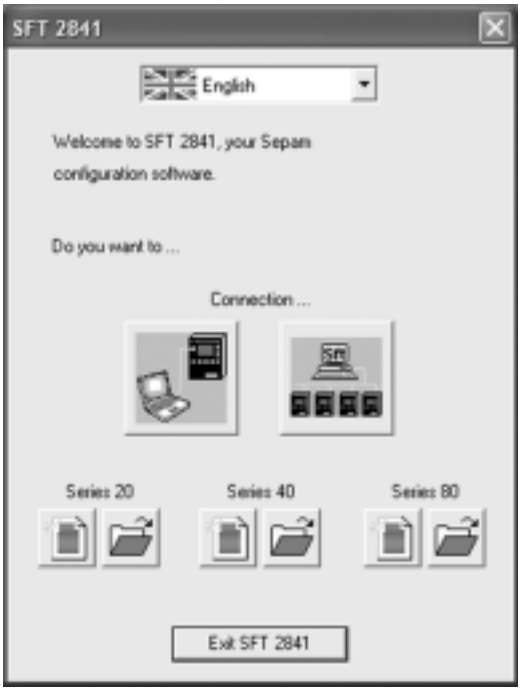
The UMI on the front panel of Sepam may be completed by the SFT2841 PC software tool, which may be used for all Sepam parameter setting, local operation and customization functions.

The SFT2841 setting and operating software is supplied on CD-ROM, along with the SFT2826 program for recovering disturbance recording files, the interactive introduction to the Sepam range, and all the Sepam documentation in PDF.

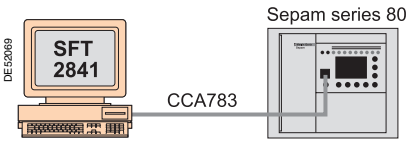
The CCA783 PC connecting cord, to be ordered separately, connects the PC to the port on the Sepam front panel, so that the SFT2841 package can be used in point-to-point connected mode.

PE50336

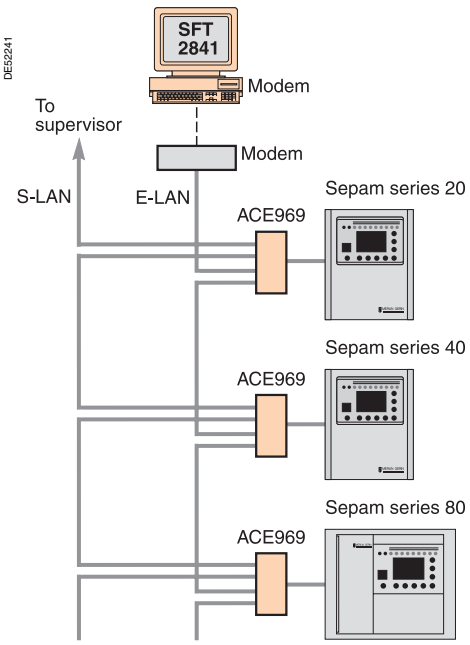
SFT2841 setting and operating software
Welcome window



Welcome window.



SFT2841 connected to a single Sepam unit.



SFT2841 connected to a Sepam network.

Description

The SFT2841 welcome window opens when the program is launched.
It lets you choose the language for the SFT2841 screens, and provides access to the Sepam parameter and protection-setting files:
- in disconnected mode, you can open or create a parameter and protection-setting file for a Sepam series 20, Sepam series 40 or Sepam series 80
- when connected to a single Sepam unit, you can access the parameter and protection-setting file for the Sepam unit connected to the PC
- when connected to a Sepam network, you can access the parameter and protection-setting files for a group of Sepam units connected to the PC via a communication network.

Language of SFT2841 screens

SFT2841 software can be used in English, French or Spanish. The language is selected at the top of the window.

Using SFT2841 in disconnected mode

Disconnected mode allows you to prepare parameter and protection-setting files for Sepam series 20, Sepam series 40 and Sepam series 80 prior to commissioning. The parameter and protection-setting files prepared in disconnected mode will be downloaded later to the Sepam units in connected mode.

- To create a new parameter and protection-setting file, click on the icon for the relevant Sepam family (Sepam series 20, Sepam series 40 or Sepam series 80)
- To open an existing parameter and protection-setting file, click on the icon for the relevant Sepam family (Sepam series 20, Sepam series 40 or Sepam series 80).

Using SFT2841 connected to a single Sepam unit

Connected mode to a single Sepam unit is used during commissioning:
- to upload, download and modify Sepam parameters and settings
- to have all the measurements and supporting data available for commissioning.

The PC loaded with the SFT2841 software is connected to the connector port on the front panel of the Sepam via an RS 232 port using the CCA783 cord.

To open the parameter and protection-setting file on the Sepam once it is connected to the PC, click on the icon .

Using SFT2841 connected to a Sepam network

Connected mode to a Sepam network is used during operation:
- to manage the protection system
- to check the status of the electrical distribution system
- to diagnose any incident occurring on the electrical distribution system.

The PC loaded with the SFT2841 software is connected to a group of Sepam units via a communication network (connection via serial link, telephone line or Ethernet). This network forms the E-LAN engineering network.

The connection window allows configuration of the Sepam network, and provides access to the parameter and protection-setting files of the Sepam units on the network.

To open the connection window, click on the icon .

See "Configuration of a Sepam network" for details of how to configure the E-LAN engineering network from the connection window.

SFT2841 setting and operating software
Presentation

All the setting and operating functions are available on the screen of a PC equipped with the SFT2841 software tool and connected to the PC connection port on the front panel of Sepam (run in a Windows ⩾ V98 or NT environment).
All the data used for the same task are grouped together in the same screen to facilitate operation. Menus and icons are used for fast, direct access to the required information.

Current operation
- display of all metering and operation data
- display of alarm messages with the time of appearance (date, hour, mn, s, ms)
- display of diagnosis data such as: tripping current, number of switchgear operations and cumulative breaking current
- display of all the protection and parameter settings
- display of the logic status of inputs, outputs and signal lamps.

This software is the solution suited to occasional local operation, for demanding personnel who require fast access to all the information.

Parameter and protection setting (1)
- display and setting of all the parameters of each protection function in the same page
- program logic parameter setting, parameter setting of general installation and Sepam data
- input data may be prepared ahead of time and transferred into the corresponding Sepam units in a single operation (downloading function).

Main functions performed by SFT2841:
- changing of passwords
- entry of general characteristics (ratings, integration period, …)
- setting Sepam date and time
- entry of protection settings
- changing of program logic assignments
- enabling/disabling of functions
- saving of files.

Saving
- protection and parameter setting data may be saved
- printing of reports is possible as well.

This software may also be used to recover disturbance recording files and provide graphic display using the SFT2826 software tool.

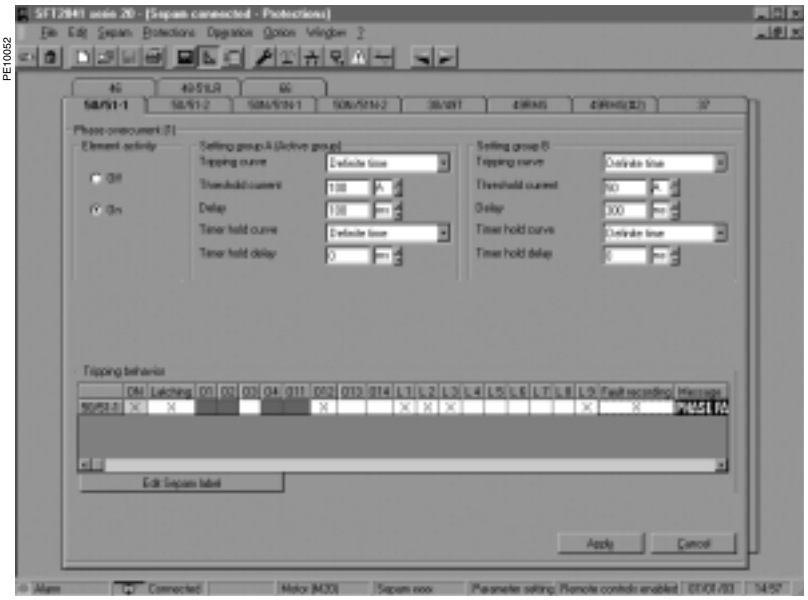
Operating assistance
Access from all the screens to a help section which contains all the technical data required for Sepam installation and use.

(1) *Modes accessed via 2 passwords (protection setting level, parameter setting level).*

PE10051

Example of a measurement display screen (Sepam M20).

PE10052



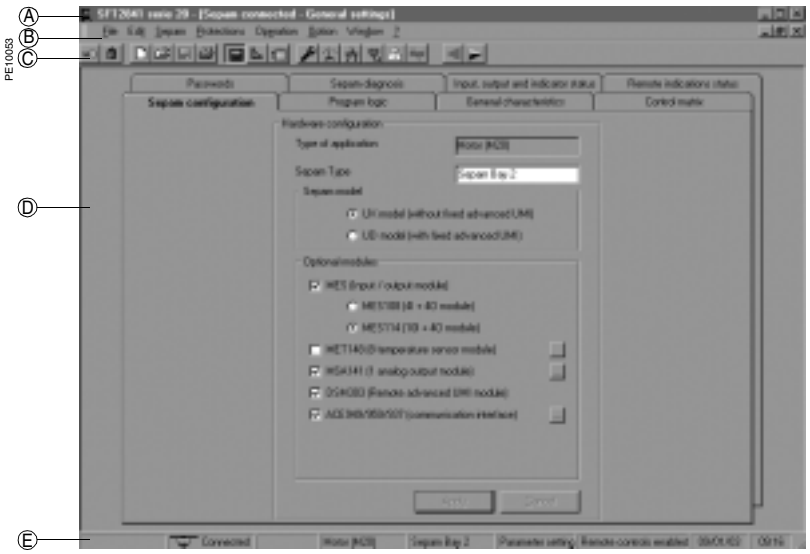
Example of a phase overcurrent protection setting screen.

SFT2841 setting and operating software
General screen organization

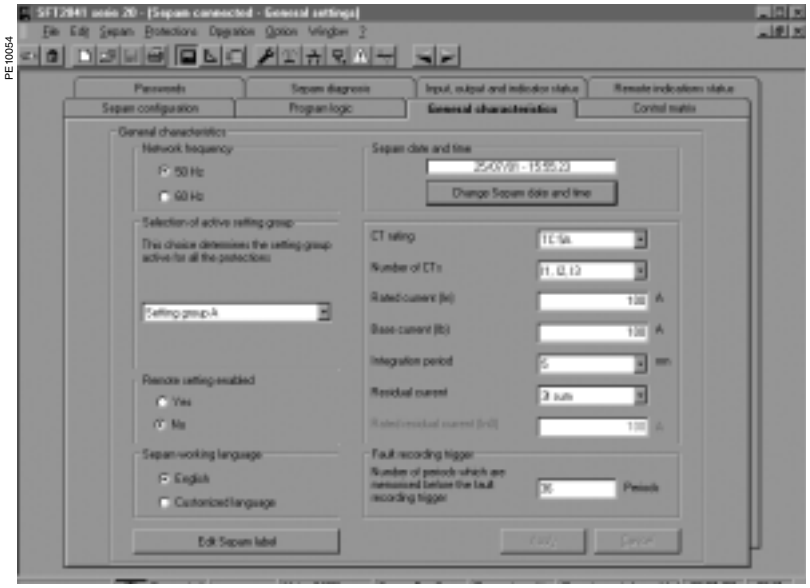
A Sepam document is displayed on the screen via a graphic interface that has the conventional Windows features.
All the SFT2841 software screens are set up in the same way, i.e.:
■ Ⓐ : title bar, with:
□ name of the application (SFT2841)
□ identification of the Sepam document displayed
□ window manipulation handles
■ Ⓑ : menu bar, to access all the SFT2841 software functions (unavailable functions are dimmed)
■ Ⓒ : toolbar, a group of contextual icons for quick access to the main functions (also accessed via the menu bar)
■ Ⓓ : work zone available to the user, presented in the form of tab boxes
■ Ⓔ : status bar, with the following information relating to the active document:
alarm on
□ identification of the connection window
□ SFT2841 operating mode, connected or not connected,
□ type of Sepam
□ Sepam editing identification
□ identification level
□ Sepam operating mode
□ PC date and time.

On-line help

The operator may look up on-line help at any time via the "?" command in the menu bar.
To use the on-line help, a browser such as Netscape Navigator or Internet Explorer MS is required.



Example of Sepam configuration screen.



Example of general characteristics screen.

7

SFT2841 setting and operating software
Use of the software

Not connected to Sepam mode

Sepam parameter and protection setting

The parameter and protection setting of a Sepam using SFT2841 consists of preparing the Sepam file containing all the characteristics that are specific to the application, a file that is then downloaded into Sepam at the time of commissioning.

Operating mode:

■ create a Sepam file for the type of Sepam to be set up (the newly created file contains the Sepam factory-set parameter and protection settings)

■ modify the "Sepam" page function sheet parameters and the "Protections" page function sheet protection settings.

A guided mode may be used to go through all the function sheets to be modified in the natural order. The screens may be sequenced in guided mode by means of the "Previous screen" and "Next screen" functions in the "Options" menu, which are also available in the form of icons in the toolbar.

The screens / function sheets are sequenced in the following order:

1. "Sepam configuration",
2. "Program logic",
3. "General characteristics",
4. protection setting screens, according to the type of Sepam,
5. "Control matrix"

Modification of function sheet contents:

■ the parameter and protection setting input fields are suited to the type of value:

□ choice buttons

□ numerical value input fields

□ dialogue box (Combo box)

■ the modifications made to a function sheet are to be "Applied" or "Canceled" before the user goes on to the following function sheet

■ the consistency of the parameter and protection settings entered is checked:

□ a clear message specifies the inconsistent value in the function sheet opened

□ values which become inconsistent following the modification of a parameter are replaced by "*****" and must be corrected.

Connected to Sepam mode

Precaution

When a laptop is used, given the risks inherent to the accumulation of static electricity, the customary precaution consists of discharging in contact with an earthed metal frame before phsycially connecting the CCA783 cord.

Plugging into Sepam

■ plugging of the 9-pin connector (SUB-D type) into one of the PC communication ports. Configuration of the PC communciation port via the "Communication port" function in the "Options" menu

■ plugging of the 6-pin connector into the connector (round minidin type) situated behind the blanking plate on the front panel of Sepam or the DSM303 module.

Connection to Sepam

2 possibilities for setting up the connection between SFT2841 and Sepam:

■ "Connection" function in the "File" menu

■ choice of "connect to the Sepam" at the start-up of SFT2841.

Once the connection with Sepam has been established, "Connected" appears in the status bar, and the Sepam connection window may be accessed in the work zone.

User identification

The window intended for the entry of the 4-digit password is activated:

■ via the "Passwords" tab

■ via the "Identification" function in the "Sepam" menu

■ via the "Identification" icon .

The "return to Operating mode" function in the "Passwords" tab removes access rights to parameter and protection setting mode.

Downloading of parameters and protection settings

Parameter and protection setting files may only be downloaded in the connected Sepam in Parameter setting mode.

Once the connection has been established, the procedure for downloading a parameter and protection setting file is as follows:

■ activate the "Download Sepam" function in the "Sepam" menu

■ select the *.rpg file which contains the data to be downloaded

■ acknowledge the end of operation report.

Return to factory settings

This operation is only possible in Parameter setting mode, via the "Sepam" menu. All of the Sepam general characteristics, protection settings and the control matrix go back to the default values.

Uploading of parameter and protection settings

The connected Sepam parameter and protection setting file may only be uploaded in Operating mode.

Once the connection has been established, the procedure for uploading a parameter and protection setting file is as follows:

■ activate the "Upload Sepam" function in the "Sepam" menu

■ select the *.rpg file that is to contain the uploaded data

■ acknowledge the end of operation report.

Local operation of Sepam

Connected to Sepam, SFT2841 offers all the local operating functions available in the advanced UMI screen, plus the following functions:

■ setting of Sepam internal clock, via the "general characteristics" tab. It should be noted that Sepam saves the date and time, in case the auxiliary power supply fails (< 24 hours)

■ implementation of the disturbance recording function, via the "Fault recording" menu "OPG": validation/inhibition of the function, recovery of Sepam files, start-up of SFT2826

■ consultation of the history of the last 64 Sepam alarms, with time-tagging

■ access to Sepam diagnostic data, in the "Sepam" tab box, included in "Sepam diagnosis"

■ in Parameter setting mode, the switchgear diagnositic values may be modified: operation counter, cumulative breaking current to reset the values after a change of breaking device.

SFT2841 setting and operating software
Configuration of a Sepam network

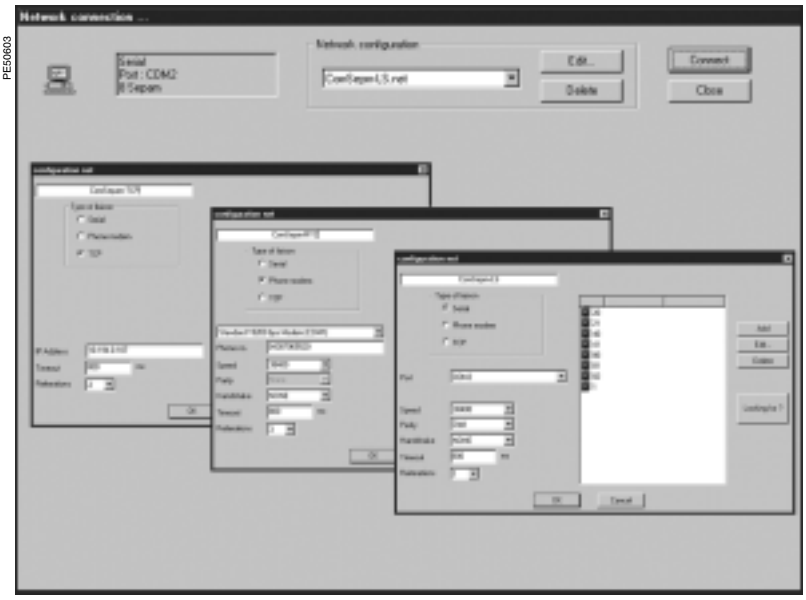
Connection window
The SFT2841 software connection window is used:
- to select an existing Sepam network or configure a new one
- to set up the connection to the selected Sepam network
- to select one Sepam unit from the network and access its parameters, settings and operation and maintenance information.

Configuration of a Sepam network
Several configurations can be defined for the various Sepam installations.
A Sepam network configuration is identified by a name. It is saved on the SFT2841 PC in a file in the SFT2841 installation directory (default: C:\Program Files\ Schneider\SFT2841\Net).

Configuration of a Sepam network is in 2 parts:
- configuration of the communication network
- configuration of the Sepam units.

Configuration of the communication network
To configure the communication network, first define:
- the type of link between the PC and the Sepam network
- the communication parameters, according to the type of link selected:
  - direct serial link
  - link via Ethernet TCP/IP
  - link via telephone modem.

PE50603



Configuration windows for the communication network, according to the type of link: direct serial link, link via telephone modem (PSTN) or link via Ethernet TCP/IP.

SFT2841 setting and operating software
Configuration of a Sepam network

PE50588

Configuration window for the serial link communication network.

Direct serial link

The Sepam units are connected to an RS 485 (or fiber-optic) multidrop network. Depending on the serial link interfaces available on the PC, the PC itself will be connected either directly to the RS 485 network (or fiber-optic HUB), or via an RS 232/RS 485 converter (or fiber-optic converter).

The communication parameters to be defined are:
- port: communication port used on the PC
- speed: 4800, 9600, 19200 or 38400 bauds
- parity: None, Even or Odd
- handshake: None, RTS or RTS-CTS
- time-out: from 100 to 3000 ms.
- number of retries: from 1 to 6.

PE50589

Configuration window for the Ethernet TCP/IP communication network.

Link via TCP/IP Ethernet

The Sepam units are connected to an RS 485 multidrop network over an Ethernet Modbus TCP/IP gateway (for example: EGX gateway).

Configuration of the Modbus TCP/IP gateway
See the setup manual for the gateway used.
In general, the gateway should be assigned an IP address.
The configuration parameters for the gateway's RS 485 interface must be defined in accordance with the Sepam communication interface configuration:
- speed: 4800, 9600, 19200 or 38400 bauds
- character format: 8 data bits + 1 stop bit + parity (none, even, odd).

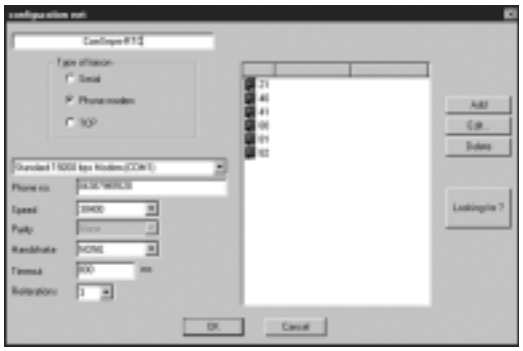
Configuration of communication on SFT2841
When configuring a Sepam network on SFT2841, the following communication parameters must be defined:
- IP address: IP address of the remote Modbus TCP/IP gateway
- time-out: from 100 to 3000 ms.

A time-out of between 800 ms and 1000 ms is sufficient in most installations.
Communication via the TCP/IP gateway may, however, be slowed down if other applications want Modbus TCP/IP access at the same time.
The time-out value should then be increased (2 to 3 seconds).
- number of retries: from 1 to 6.

Note 1: *SFT2841 uses the Modbus TCP/IP communication protocol.*
Although communication is IP-based, use of SFT2841 is restricted to a local installation network based on an Ethernet network (LAN – Local Area Network).
The operation of SFT2841 over a WAN (Wide Area Network) cannot be guaranteed because of the presence of some routers or firewalls that may reject the Modbus protocol, causing communication times that would be incompatible with Sepam.

Note 2: *SFT2841 allows Sepam protection settings to be modified, and direct activation of the outputs. These operations, which could involve the operation of electrical switchgear (opening and closing), and thus risk the safety of people and installations, are protected by the Sepam password. In addition to this protection, the E-LANs and S-LANs must be designed as private networks, protected from external actions by all suitable methods.*

PE50590



Configuration window for the communication network via telephone modem.

Link via telephone modem

The Sepams are connected to an RS 485 multidrop network using an industrial PSTN modem.
This modem is the called modem. It must first be configured, either via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches
(see the modem manufacturer's manual).

The PC may use an internal or an external modem. This modem on the PC side is always the calling modem. It must be installed and configured in accordance with the Windows modem installation procedure.

Configuration of the calling modem in SFT2841

When configuring a Sepam network, SFT2841 displays the list of all the modems installed on the PC:
The communication parameters to be defined are:

- modem: select one of the modems listed by SFT2841
- telephone no.: no. of the remote modem to be called
- speed: 4800, 9600, 19200 or 38400 bauds
- parity: none (not adjustable)
- handshake: none, RTS or RTS-CTS
- time-out: from 100 to 3000 ms.

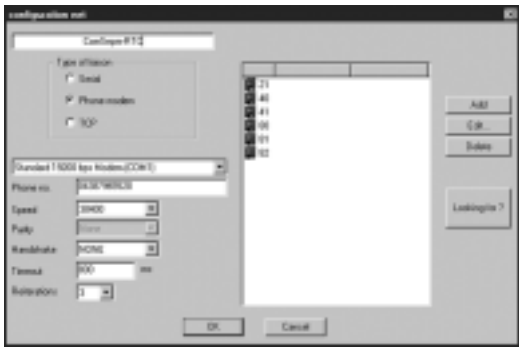
Communication via modem and telephone network is slowed considerably because of the transit time through the modems. A time-out of between 800 ms and 1000 ms is sufficient in most 38400 baud installations. In some cases, the poor quality of the telephone network may require a slower speed (9600 or 4800 bauds). The time-out value should then be increased (2 to 3 seconds).

- number of retries: from 1 to 6.

Note: *the speed and parity of the calling modem must be configured under Windows with the same values as for SFT2841.*

SFT2841 setting and operating software
Configuration of a Sepam network

PE50590



Configuration window for the communication network via telephone modem.

Configuration of called modem

The modem on the Sepam side is the called modem. It must first be configured, either via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

Modem RS 485 interface

In general, the configuration parameters for the modem's RS 485 interface must be defined in accordance with the Sepam communication interface configuration:

- speed: 4800, 9600, 19200 or 38400 bauds
- character format: 8 data bits + 1 stop bit + parity (none, even, odd)

Telephone network interface

Modern modems offer sophisticated features such as checking the quality of the telephone line, error correction and data compression. These options are not justified for communication between SFT2841 and Sepam, which is based on the Modbus RTU protocol. Their effect on communication performance may be the opposite of the expected result.

It is therefore highly advisable to:

- invalidate the error correction, data compression and telephone line quality monitoring options
- use the same end-to-end communication speed between:
  - the Sepam network and the called modem
  - the called modem (Sepam side) and the calling modem (PC side)
  - the PC and the calling modem (see recommended configurations table).

Sepam network	Telephone network	PC modem interface
38400 bauds	V34 modulation, 33600 bauds	38400 bauds
19200 bauds	V34 modulation, 19200 bauds	19200 bauds
9600 bauds	V32 modulation, 9600 bauds	9600 bauds

Industrial configuration profile

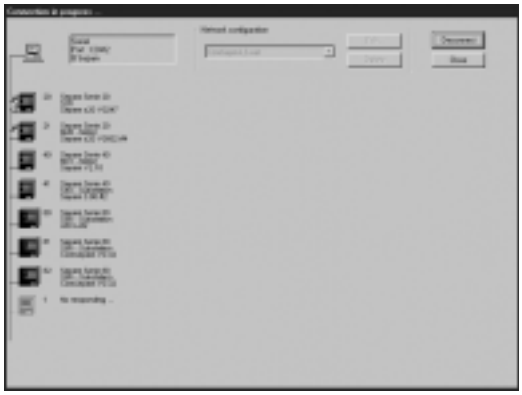
The following table shows the main characteristics of the modem on the Sepam side. These characteristics match a configuration profile commonly known as an "industrial profile", as against the configuration of modems used in offices.

Depending on the type of modem used, the configuration will either be via AT commands from a PC using HyperTerminal or the configuration tool that may have been supplied with the modem, or by setting switches (see the modem manufacturer's manual).

Characteristics of the "industrial profile" configuration	AT command
Transmission in buffered mode, without error correction	\N0 (forces &Q6)
Data compression deactivated	%C0
Line quality monitoring deactivated	%E0
DTR signal assumed to be permanently off (allows the modem connection to be established automatically on an incoming call)	&D0
CD signal off when carrier is present	&C1
All reports made to Sepam blocked	Q1
Character echo suppression	E0
No flow control	&K0

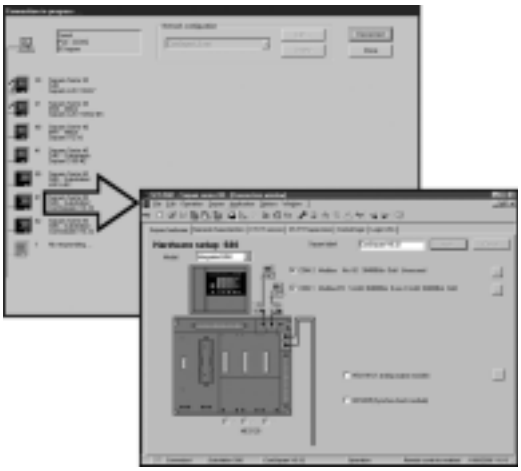
SFT2841 setting and operating software
Configuration of a Sepam network

PE50591



Sepam network connected to SFT2841.

PE50592



Access to parameters and settings for a Sepam series 80 connected to a communication network.

Identification of Sepam units connected to the communication network

The Sepam units connected to the communication network are identified by their Modbus address.
These addresses may be configured in either of the following ways:
- manually, one by one:
  - the "Add" button is used to define a new Sepam device; it is allocated a default Modbus address
  - the "Edit" button is used to modify the Modbus address if necessary
  - the "Delete" button removes a device from the configuration
- automatically, by running an automatic search of the Sepam units connected:
  - the "Automatic search"/"Stop search" button starts or interrupts the search
  - when SFT2841 recognizes a Sepam unit, its Modbus address and type are shown on screen
  - when a Modbus device other than Sepam responds to SFT2841, its Modbus address is displayed. The text "???" indicates that the device is not a Sepam.

The Sepam network configuration is saved in a file when the window closes, by pressing the "OK" button.

Access to Sepam information

To establish communication between SFT2841 and a Sepam network, select the Sepam network configuration you want, and press "Connect".
The Sepam network is displayed in the connection window. SFT2841 polls all the equipment defined in the selected configuration. Each Sepam queried is represented by an icon:
- Sepam series 20 or Sepam series 40 actually connected to the network
- Sepam series 80 actually connected to the network
- Sepam configured but not connected to the network
- Device other than Sepam connected to the network.

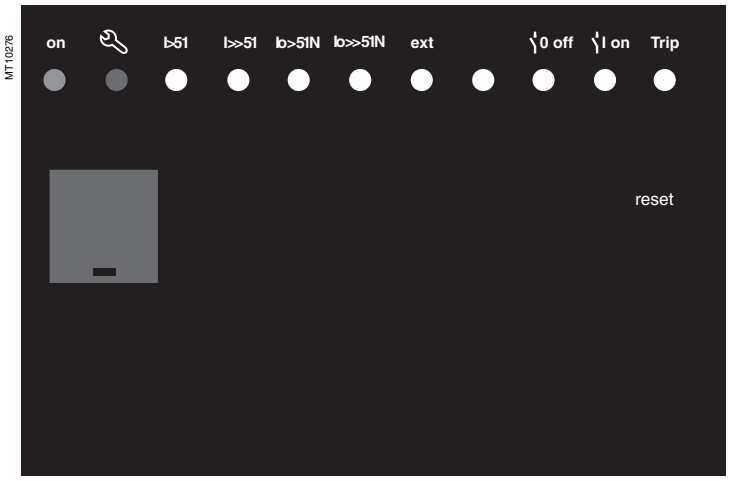
A summary report of each Sepam detected as present is also displayed:
- Sepam Modbus address
- type of application and Sepam identification
- any alarms present
- any minor/major faults present.

To access parameters, settings and operation and maintenance information for a particular Sepam, click on the icon for that Sepam. SFT2841 then establishes a point-to-point connection with the selected Sepam.

UMI on front panel
Presentation

Basic UMI

This UMI includes:
- 2 signal lamps indicating Sepam operating status:
  - green "**on**" indicator: device on
  - red indicator: device unavailable (initialization phase or detection of internal failure)
- 9 parameterizable yellow signal lamps, fitted with a standard label (with SFT2841, a customized label can be printed on a laser printer)
- key for clearing faults and resetting
- 1 connection port for the link with the PC (CCA783 cord), the connector is protected by a sliding cover.



Fixed or remote advanced UMI

In addition to the basic UMI functions, this version provides:
- **a "graphic" LCD display** for the display of measurements, parameter/protection settings and alarm and operating messages.

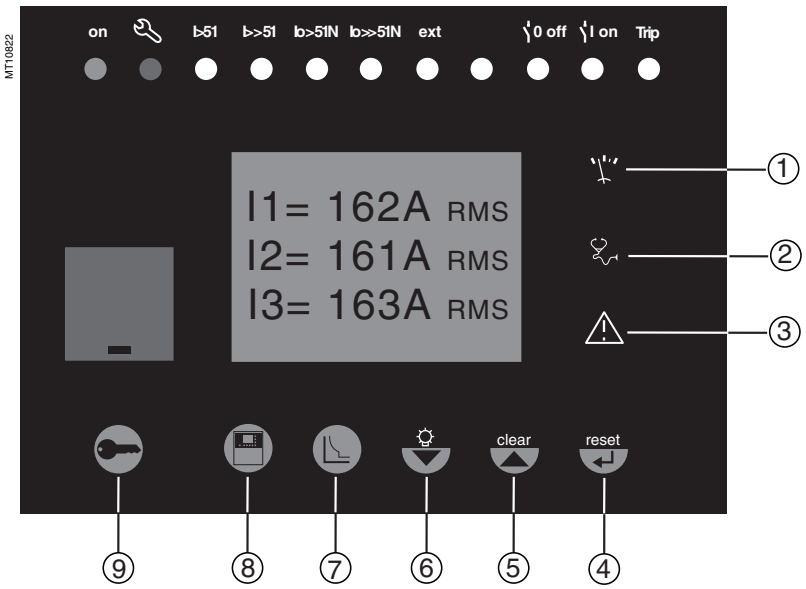
The number of lines, size of characters and symbols are in accordance with the screens and language versions.
The LCD display retrolighting may be activated by pressing a key.
- **a 9-key keypad with 2 operating modes:**
  - **white keys for current operation:**

① display of measurements
② display of "switchgear, network diagnosis" data
③ display of alarm messages
④ resetting
⑤ acknowledgment and clearing of alarms.

  - **blue keys activated in parameter and protection setting mode:**

⑦ access to protection settings
⑧ access to Sepam parameters settings including date and time **(1)**
⑨ used to enter the 2 passwords required to change protection and parameter settings.

The "↵, ▲, ▼" (④, ⑤, ⑥) keys are used to browse through the menus and to scroll and accept the values displayed.
⑥ "**lamp test" keys**:
switching on sequence of all the signal lamps.



***(1)** Date/time saved in case the auxiliary power supply fails (< 24 hours).*

Access to measurements and parameters

The measurements and parameters may be accessed using the metering, diagnosis, status and protection keys. They are arranged in a series of screens as shown in the diagram opposite.

■ the data are split up by category in 4 loops, associated with the following 4 keys:

□ key : measurements

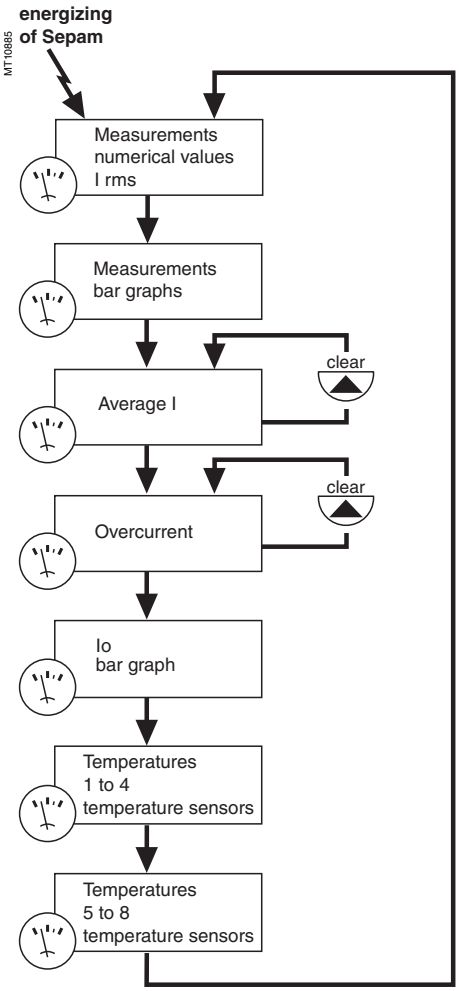
□ key : switchgear diagnosis and additional measurements

□ key : general settings

□ key : protection settings.

■ when the user presses a key, the system moves on to the next screen in the loop. When a screen includes more than 4 lines, the user moves about in the screen via the cursor keys (,).

Example: measurement loop



Protection and parameter setting modes

There are 3 levels of use:

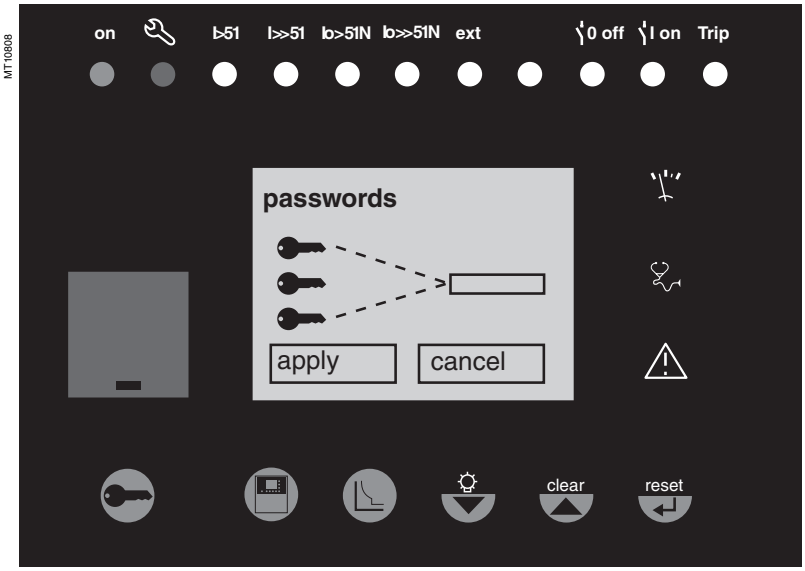
■ operator level: used to access all the screens in read mode and does not require any passwords

■ protection setter level: requires the entry of the first password (key), allows protection setting (key)

■ parameter setter level: requires the entry of the second password (key), allows modification of the general settings as well (key).

Only general setters may modify the passwords.

The passwords have 4 digits.

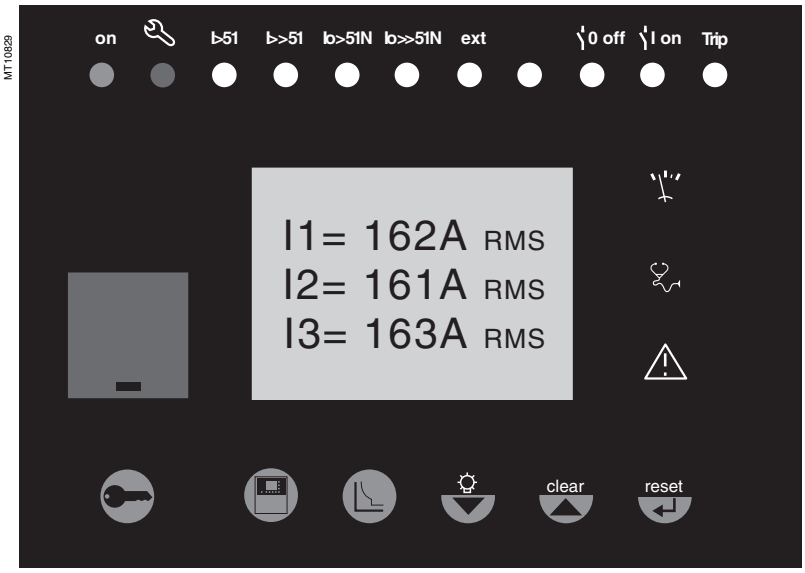


7

Advanced UMI
White keys for current operation

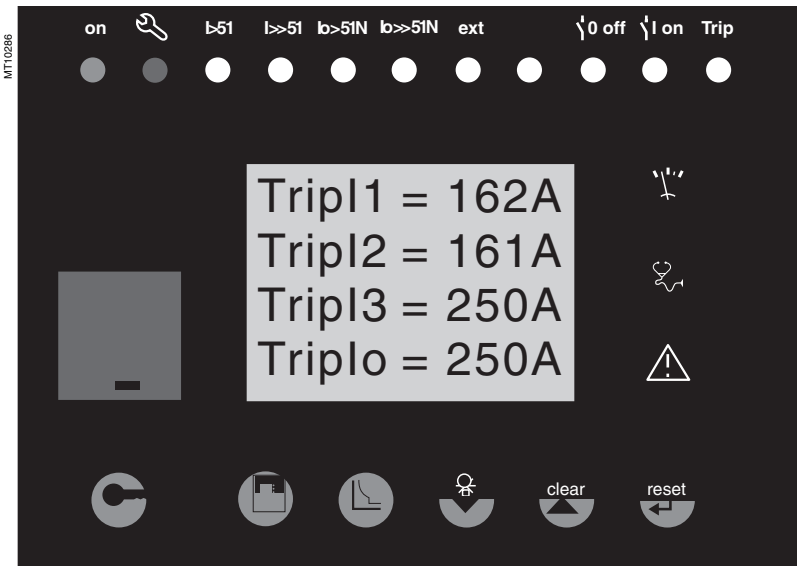
key

The "metering" key is used to display the variables measured by Sepam.



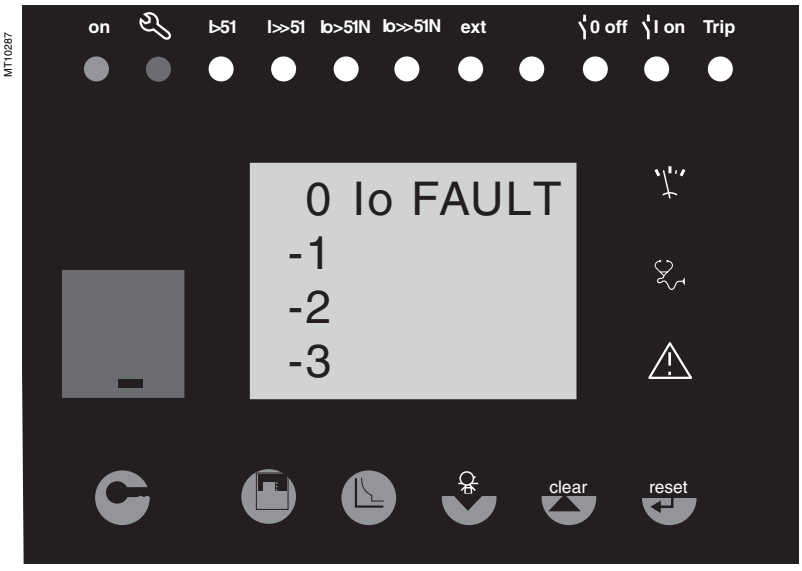
key

The "diagnosis" key provides access to diagnostic data on the breaking device and additional measurements, to facilitate fault analysis.



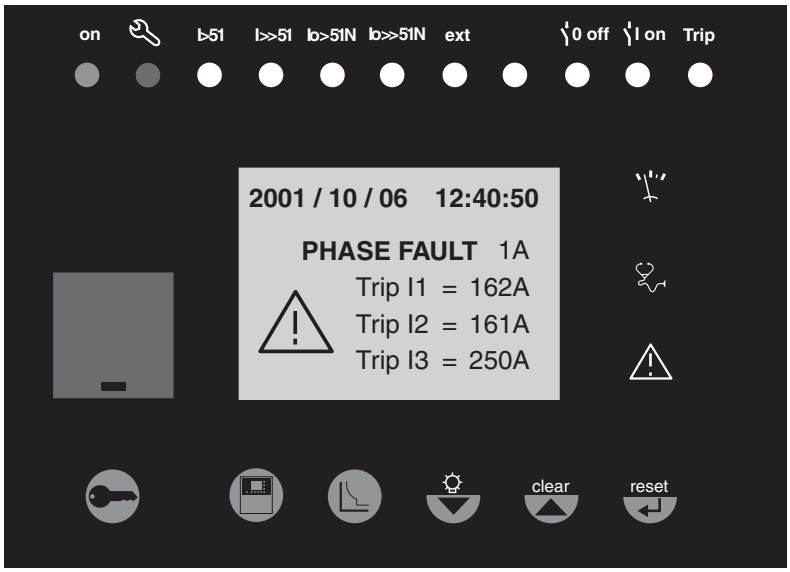
key

The "alarms" key is used to consult the 16 most recent alarms that have not yet been cleared.



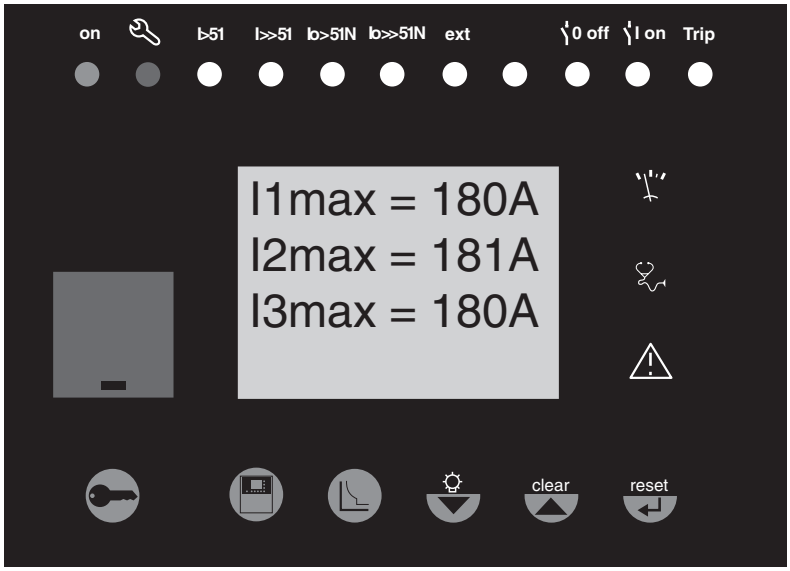
reset key

The "reset" key resets Sepam (extinction of signal lamps and resetting of protection units after the disappearance of faults).
The alarm messages are not erased.



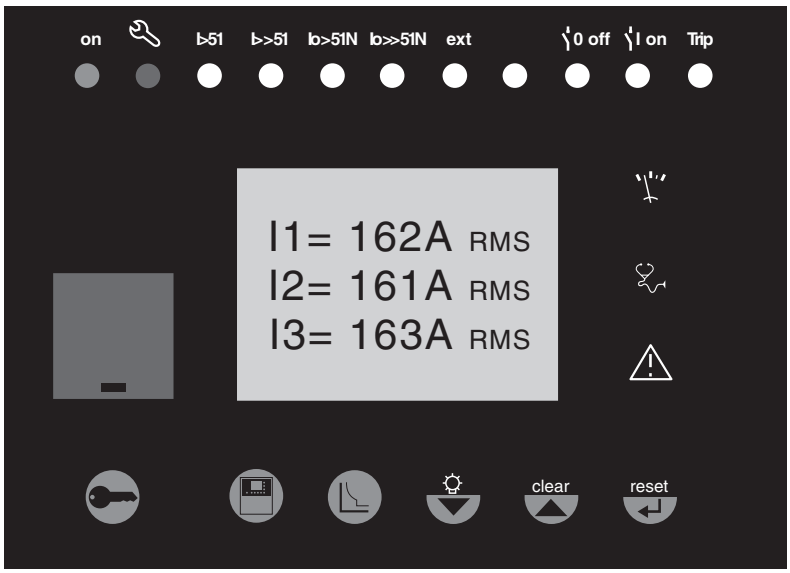
clear key

When an alarm is present on the Sepam display, the "clear" key is used to return to the screen that was present prior to the appearance of the alarm or to a less recent unacknowledged alarm. Sepam is not reset.
In the metering or diagnosis or alarm menus, the "clear" key may be used to reset the average currents, peak demand currents, running hours counter and alarm stack when they are shown on the display.



key

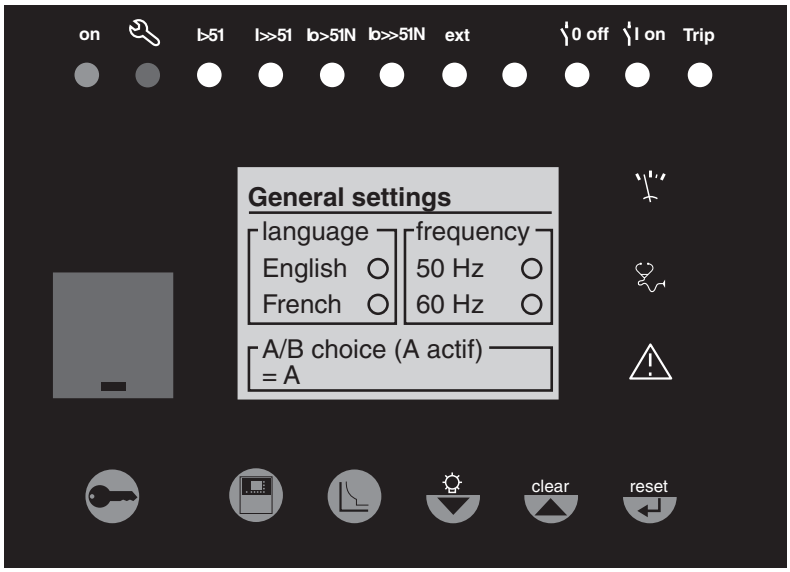
Press the "lamp test" key for 5 seconds to start up a LED and display test sequence.
When an alarm is present, the "lamp test" key is disabled.



Advanced UMI
Blue keys for parameter and protection setting

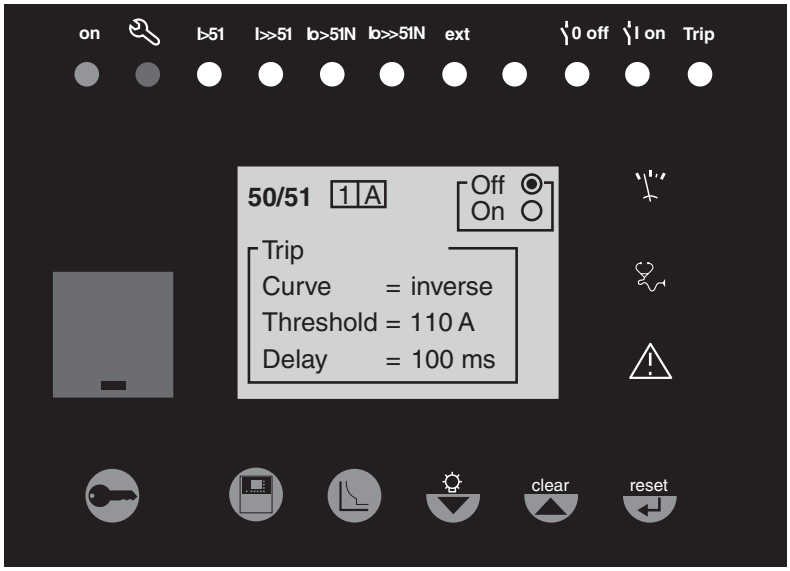
key

The "status" key is used to display and enter the Sepam general settings including setting the Sepam date and time. They define the protected equipment characteristics and the different optional modules.



key

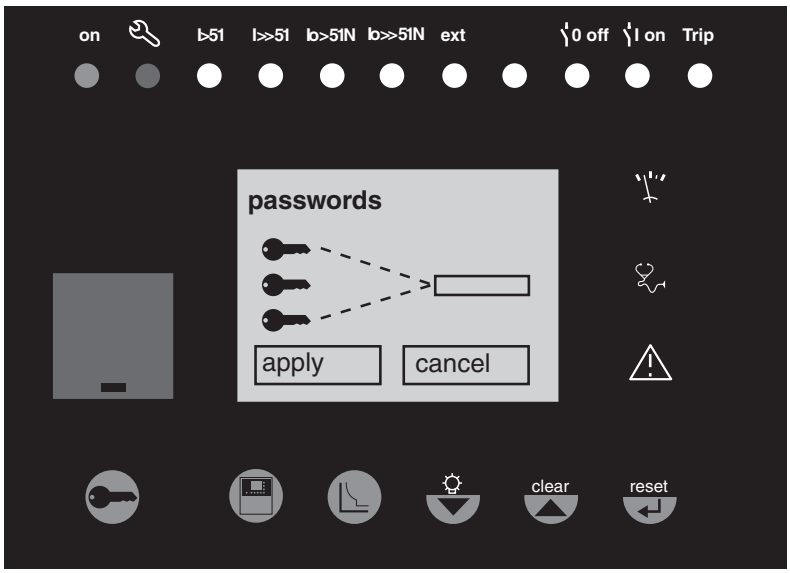
The "protection" key is used to display, set and enable or disable the protection units.



key

The "wrench" key is used to enter the passwords for access to the different modes:
- protection setting
- parameter setting.

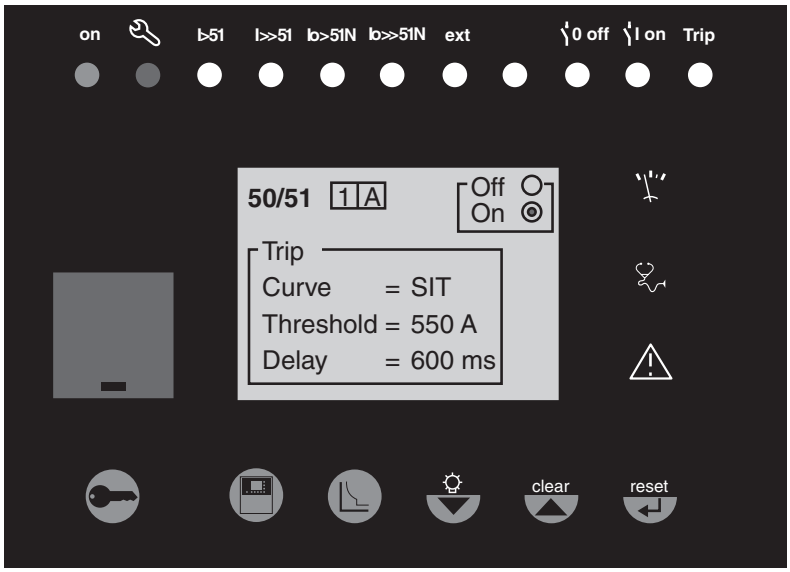
and return to "operating" mode (with no passwords).



Advanced UMI
Blue keys for parameter and protection setting

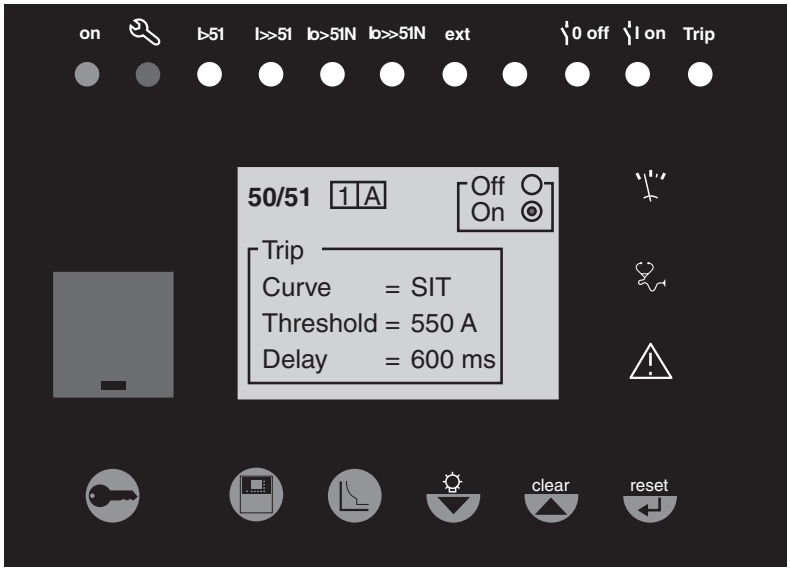
reset key

The reset key is used to confirm the protection settings, parameter settings and passwords.



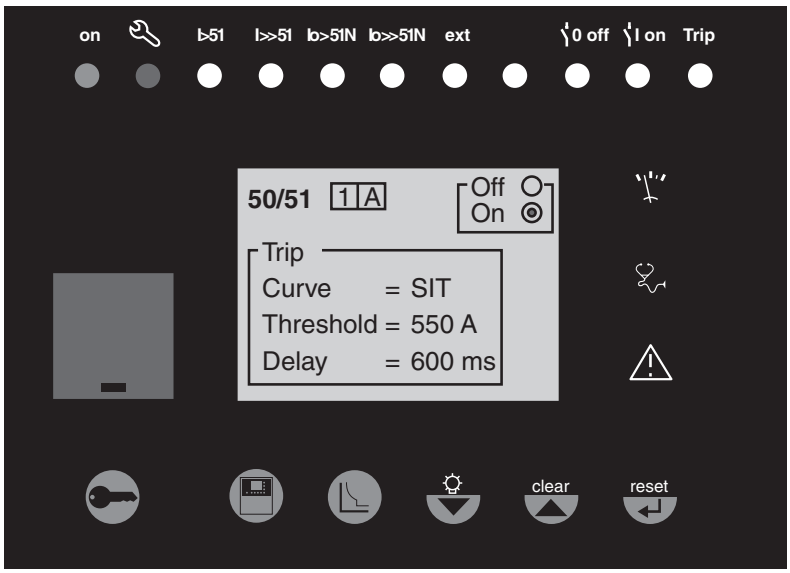
clear key

When there are no alarms on the Sepam display and the user is in the status, protection or alarm menu, the ▲ key is used to move the cursor upward.



key

When there are no alarms on the Sepam display and the user is in the status, protection or alarm menu, the ▼ key is used to move the cursor downward.



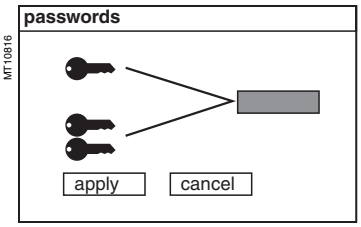
Use of passwords

Sepam has two 4-digit passwords:
- the first password, symbolized by a key, is used to modify the protection settings
- the second password, symbolized by two keys, is used to modify the protection settings and all the general settings.

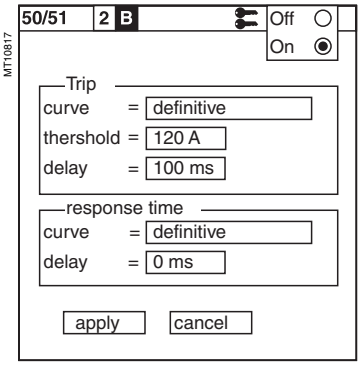
The 2 factory-set passwords are: 0000

Entry of passwords

Press the key to display the following screen:



Press the key to position the cursor on the first digit.
0 X X X
Scroll the digits using the cursor keys (▲, ▼), then confirm to go on to the next digit by pressing the key.
Do not use characters other than numbers 0 to 9 for each of the 4 digits.
When the password for your qualification level is entered, press the ▼ key to position the cursor on the apply box. Press the key again to confirm.
When Sepam is in protection setting mode, a key appears at the top of the display.
When Sepam is in parameter setting mode, two keys appear at the top of the display.



Access to the protection setting or parameter setting modes is disabled:
- by pressing the key
- automatically if no keys are activated for more than 5 minutes.

Modification of passwords

Only the parameter setting qualification level (2 keys) or the SFT2841 allow modification of the passwords. Passwords are modified in the general settings screen, key.

Loss of passwords

If the factory-set passwords have been modified and the latest passwords entered have been irretrievably lost by the user, please contact your local after-sales service representative.

Entry of parameters or settings

Principle applicable to all Sepam screens

(example of phase overcurrent protection)
- enter the password
- access the corresponding screen by successively pressing the key
- move the cursor by pressing the ▼ key for access to the desired field (e.g. curve)
- press the key to confirm the choice, then select the type of curve by pressing the ▼ or ▲ key and confirm by pressing the key
- press the ▼ key to reach the following fields, up to the apply box. Press the key to confirm the setting.

Entry of numerical values

(e.g. current threshold value).
- position the cursor on the required field using the ▼ ▲ keys and confirm the choice by pressing the key
- select the first digit to be entered and set the value by pressing the ▲ ▼ keys (choice of ___. 0……9)
- press the key to confirm the choice and go on to the following digit.

The values are entered with 3 significant digits and a period.
The unit (e.g. A or kA) is chosen using the last digit.
- press the key to confirm the entry, then press the key for access to the following field
- all of the values entered are only effective after the user confirms by selecting the apply box at the bottom of the screen and presses the key.

Default parameter setting

The Sepam units are delivered with default parameter setting and protection setting according to the type of application.
These "factory" settings are also used with the SFT2841 software:
■ for the creation of new files in not connected mode
■ for a return to the "factory" settings in connected mode.

S20, T20 and M20 applications

Hardware configuration
■ identification: Sepam xxxx
■ model: UX
■ MES module: absent
■ MET module: absent
■ MSA module: absent
■ DSM module: present
■ ACE module: absent.

Output parameter setting
■ outputs used: O1 to O4
■ shunt trip units: O1, O3
■ undervoltage trip units: O2, O4
■ impulse mode: no (latched).

Program logic
■ circuit breaker control: no
■ logic discrimination: no
■ logic input assignment: not used.

General characteristics
■ network frequency: 50 Hz
■ group of settings: A
■ enable remote setting: no
■ working language: English
■ CT rating: 5 A
■ number of CTs: 3 (I1, I2, I3)
■ rated current In: 630 A
■ basic current Ib: 630 A
■ integration period: 5 mn
■ residual current: 3I sum
■ pre-trig for disturbance recording: 36 periods.

Protection functions
■ all the protections are "off"
■ the settings comprise values and choices that are informative and consistent with the general characteristics by default (in particular rated current In)
■ tripping behavior:
□ latching: yes
□ activation of output O1: yes
□ disturbance recording triggering: with.

Control matrix
Each Sepam has program logic by default according to the type (S20, T20,…) as well as messages for the different signal lamps.
The functions are assigned according to the most frequent use of the unit. This parameter setting may be customized if required using the SFT2841 software package.
■ S20 application:
□ activation of output O2 upon protection tripping
□ activation of indicators according to front panel markings
□ watchdog on output O4
□ disturbance recording triggering upon signal pick-up.
■ complements for T20 application:
□ activation of O1 without latching upon tripping of temperature monitoring 1 to 7
□ activation of O1 and indicator L9 without latching upon thermal overload tripping.
■ complements for M20 application:
□ activation of outputs O1 and O2 and indicator L9 upon tripping of functions 37 (phase undercurrent) and 51LR (locked rotor)
□ activation of output O2 upon tripping of function 66 (starts per hour)
□ latching for function 51LR.

Default parameter setting

B21[1] and B22 applications

Hardware configuration
- identification: Sepam xxxx
- model: UX
- MES module: absent
- MET module: absent
- MSA module: absent
- DMS module: present
- ACE module: absent.

Output parameter setting
- outputs used: O1 to O4
- shunt coils: O1 to O3
- undervoltage coils: O4
- impulse mode: no (latched).

Program logic
- circuit breaker control: no
- assignment of logic inputs: not used.

General characteristics
- network frequency: 50 Hz
- enable remote setting: no
- working language: English
- primary rated voltage (Unp): 20 kV
- secondary rated voltage (Uns): 100 V
- voltages measured by VTs: V1, V2, V3
- residual voltage: sum of 3Vs
- pre-trig for disturbance recording: 36 periods.

Protection functions
- all the protection functions are "off"
- the settings comprise values and choices that are informative and consistent with the general characteristics by default
- latching: no
- disturbance recording triggering: with.

Control matrix
- assignment of output relays and indicators according to chart:

Functions		Outputs				Indicators								
B21	B22	O1	O2	O3	O4	L1	L2	L3	L4	L5	L6	L7	L8	L9
27D-1	27D-1		■				■							
27D-2	27D-2	■					■							■
27R	27R			■				■						
27-1	27-1		■			■								
27-2	27-2	■				■								■
27S-1	27S-1	■				■								■
27S-2	27S-2	■				■								■
27S-3	27S-3	■				■								■
59-1	59-1		■						■					
59-2	59-2	■							■					■
59N-1	59N-1		■							■				
59N-2	59N-2	■								■				■
81H	81H	■									■			■
81L-1	81L-1		■									■		
81L-2	81L-2	■											■	■
	81R	■											■	■

- disturbance recording triggering upon signal pick-up
- watchdog on output O4.

Indicator marking
L1 : U < 27
L2 : U < 27D
L3 : U < 27R
L4 : U > 59
L5 : U > 59N
L6 : F > 81H
L7 : F < 81L
L8 : F << 81L
L9 : Trip

(1) Type B21 performs the same functions as cancelled type B20.

Commissioning: principles and method

Protection relay testing

Protection relays are tested prior to commissioning, with the dual aim of maximizing availability and minimizing the risk of malfunctioning of the assembly being commissioned. The problem consists of defining the consistency of the appropriate tests, keeping in mind that the relay is always involved as the main link in the protection chain.
Therefore, protection relays based on electromechanical and static technologies must be systematically submitted to detailed testing, not only to qualify relay commissioning, but also to check that they actually are in good operating order and maintain the required level of performance.

The Sepam concept makes it possible to do away with such testing, since:
- the use of digital technology guarantees the reproducibility of the performances announced
- each of the Sepam functions has undergone full factory-qualification
- an internal self-testing system provides continuous information on the state of the electronic components and the integrity of the functions (e.g. automatic tests diagnose the level of component polarization voltages, the continuity of the analog value acquisition chain, non-alteration of RAM memory, absence of settings outside the tolerance range) and thereby guarantees a high level of availability.

Sepam is therefore ready to operate without requiring any additional qualification testing that concerns it directly.

Sepam commissioning tests

The preliminary Sepam commissining tests may be limited to a commissioning check, i.e.:
- checking of compliance with BOMs and hardware installation diagrams and rules during a preliminary general check
- checking of the compliance of the general settings and protection settings entered with the setting sheets
- checking of current or voltage input connection by secondary injection tests
- checking of logic input and output connection by simulation of input data and forcing of output status
- confirmation of the complete protection chain
- checking of the connection of the optional MET148-2 and MSA141 modules.

The various checks are described further on.

General principles

- **all the tests should be carried out with the MV cubicle completely isolated and the MV circuit breaker racked out (disconnected and open)**
- **all the tests are to be performed in the operating situation: no wiring or setting changes, even temporary changes to facilitate testing, are allowed.**

- the SFT2841 parameter setting and operating software is the basic tool for all Sepam users. It is especially useful during Sepam commissioning tests. The tests described in this document are systematically based on the use of that tool.
The commissioning tests may be performed without the SFT2841 software for Sepam units with advanced UMIs.

Method

For each Sepam:
- only carry out the checks suited to the hardware configuration and the functions activated

(A comprehensive description of all the tests is given further on)
- use the test sheet provided to record the results of the commissioning tests.

Testing and metering equipment required

Generators

■ sinusoidal AC current generator:
□ 50 or 60 Hz frequency (according to the country)
□ single-phase type, adjustable from 0 to 50 Arms
□ with connector suited to the built-in test terminal box in the current input connection diagram
■ sinusoidal AC voltage generator:
□ 50 or 60 Hz frequency (according to the country)
□ single-phase type, adjustable from 0 to 150 Vrms
□ with connector suited to the built-in test terminal box in the voltage input connection diagram
■ DC voltage generator:
□ adjustable from 48 to 250 V DC
□ for adaptation to the voltage level of the input being tested
□ with electric cord and clamps, wire grip or touch probes.

Metering devices

■ 1 ammeter, 0 to 50 A rms
■ 1 voltmeter, 0 to 150 V rms.

Computer equipment

■ PC with minimal configuration:
□ Microsoft Windows 98 / XP / 2000 / NT 4.0
□ 133 MHz Pentium processor
□ 64 MB of RAM (or 32 MB with Windows 98)
□ 64 MB free on hard disk
□ CD-ROM drive
■ SFT2841 software
■ CCA783 serial connection cord between the PC and Sepam.

Documents

■ complete connection diagram of Sepam and additional modules, with:
□ phase current input connection to the corresponding CTs via the test terminal box
□ residual current input connection
□ phase voltage input connection to the corresponding VTs via the test terminal box
□ residual voltage input connection to the corresponding VTs via the test terminal box
□ logic input and output connection
□ temperature sensor connection
□ analog output connection
■ hardware BOMs and installation rules
■ group of Sepam parameter and protection settings, available in paper format.

General examination and preliminary actions

Checking to be done prior to energizing

Apart from the mechanical state of the equipment, use the diagrams and BOMs provided by the contractor to check:

- identification of Sepam and accessories determined by the contractor
- correct earthing of Sepam (via terminal 17 of the 20-pin connector)
- conformity of Sepam auxiliary voltage (indicated on the label stuck to the right side plate of the base unitbase unit) with the auxiliary supply voltage of the switchboard (or cubicle)
- correct connection of the auxiliary voltage (terminal 1: AC or positive polarity; terminal 2: AC or negative polarity)
- presence of a residual current measurement core balance CT and/or additional modules connected to Sepam, when applicable
- presence of test terminal boxes upstream from the current inputs and voltage inputs
- conformity of connections between Sepam terminals and the test terminal boxes.

Connections

Check that the connections are tightened (with equipment non-energized).
The Sepam connectors must be correctly plugged in and locked.

Energizing

Switch on the auxiliary power supply.
Check that Sepam performs the following initialization sequence, which lasts approximately 6 seconds:

- green ON and red indicators on
- red indicator off
- pick-up of "watchdog" contact.

The first screen displayed is the phase current or phase voltage metering screen according to the application.

Implementation of the SFT2841 software for PC

- start up the PC
- connect the PC RS 232 serial port to the communication port on the front panel of Sepam using the CCA783 cord
- start up the SFT2841 software, by clicking on the related icon
- choose to connect to the Sepam to be checked.

Identification of Sepam

- note the Sepam serial number given on the label stuck to the right side plate of the base unit
- note the Sepam type and software version using the SFT2841 software, "Sepam Diagnosis" screen
- enter them in the test sheet.

Checking of parameter and protection settings

Determination of parameter and protection settings

All of the Sepam parameter and protection settings are determined ahead of time by the design department in charge of the application, and should be approved by the customer.

It is presumed that the study has been carried out with all the attention necessary, or even consolidated by a network coordination study.

All of the Sepam parameter and protection settings should be available at the time of commissioning:

- in paper file format (with the SFT2841 software, the parameter and protection setting file for a Sepam may be printed directly or exported in a text file for editing)
- and, when applicable, in the format of a file to be downloaded into Sepam using the SFT2841 software.

Checking of parameters and protection settings

Check to be made when the Sepam parameter and protection settings have not been entered or downloaded during commissioning testing, to confirm the conformity of the parameter and protection settings entered with the values determined during the study.

The aim of this check is not to confirm the relevance of the parameter and protection settings.

- go through all the parameter and protection setting screens in the SFT2841 software, in the order proposed in guided mode
- for each screen, compare the values entered in the Sepam with the values recorded in the parameter and protection setting file
- correct any parameter and protection settings that have not been entered correctly, proceeding as indicated in the SFT2841 software section of the Use chapter of this manual.

Conclusion

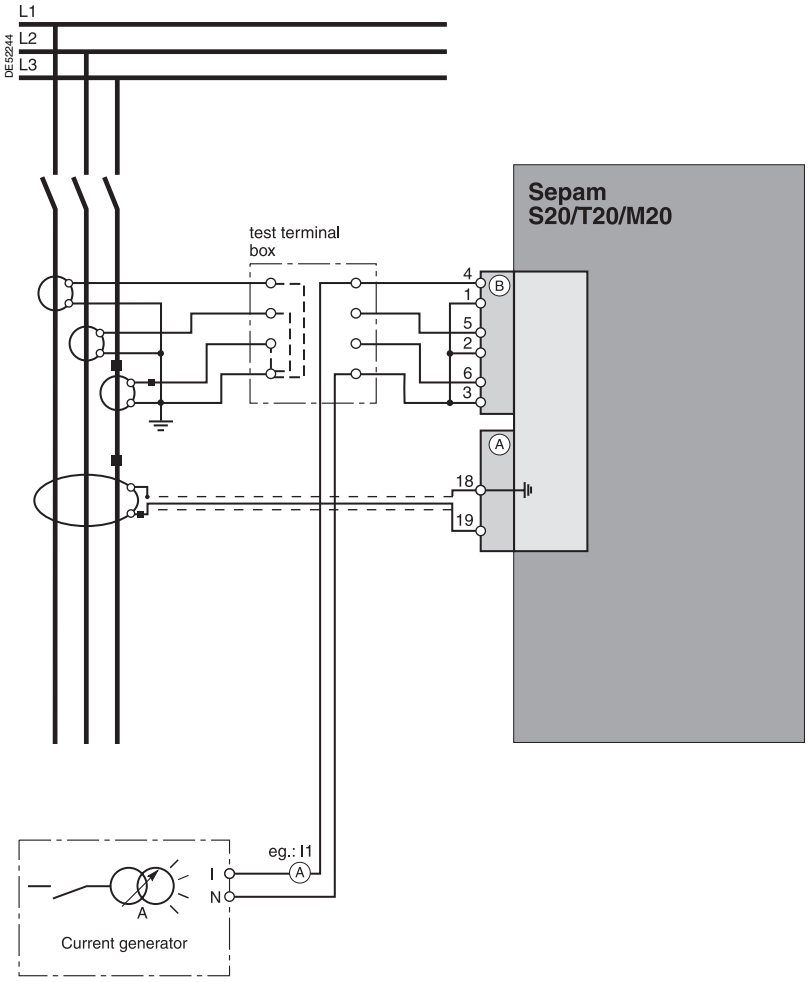
Once the checking has been done and proven to be conclusive, as of that phase, the parameter and protection settings should not be changed any further and are considered to be final.

In order to be conclusive, the tests which follow must be performed with these parameter and protection settings; no temporary modification of any of the values entered, with the aim of facilitating a test, is permissible.

Checking of phase current input connection
1 A/5 A current transformers

Description
Check to be carried out for Sepam S20, T20 or M20, when phase currents are measured by 1 A or 5 A current transformers.

Procedure
■ to inject a current into the phase 1 input, connect the single-phase generator to the test terminal box using the plug provided, in accordance with the diagram below:



■ turn on the generator
■ inject the CT rated secondary current, i.e. 1 A or 5 A
■ use the SFT2841 software to check that the phase 1 current value is approximately equal to the CT rated primary current
■ if the residual current is calculated by taking the sum of the 3 phase currents, use the SFT2841 software to check that the residual current value is approximately equal to the CT rated primary current
■ if the residual current is measured via 3 phase CTs connected to a CSH30 interposing ring CT, use the SFT2841 software to check that the residual current value is approximately equal to the CT rated primary current
■ turn off the generator
■ proceed in the same way for the other 2 phase current inputs
■ at the end of the test, put the cover back on the test terminal box.

Checking of phase current input connection
LPCT type current sensors

Description
Check to be performed for Sepam S20, T20 or M20, when phase currents are measured by LPCT-type current sensors.

Phase current measurement by LPCT sensors
- The 3 LPCT current sensors are connected via an RJ45 plug to the CCA670 connector which is to be mounted on the rear panel of Sepam, identified as (B)
- The connection of only one or two LPCT sensors is not allowed and causes Sepam to go into the fail-safe position
- The rated primary current In measured by the LPCT sensors is to be entered as a Sepam general setting and configured by microswitches on the CCA670 connector.

Procedure
The tests to be carried out to check phase current input connections are the same whether the phase currents are measured by CTs or LPCT sensors. Only the Sepam current input connection procedure and current injection values change.

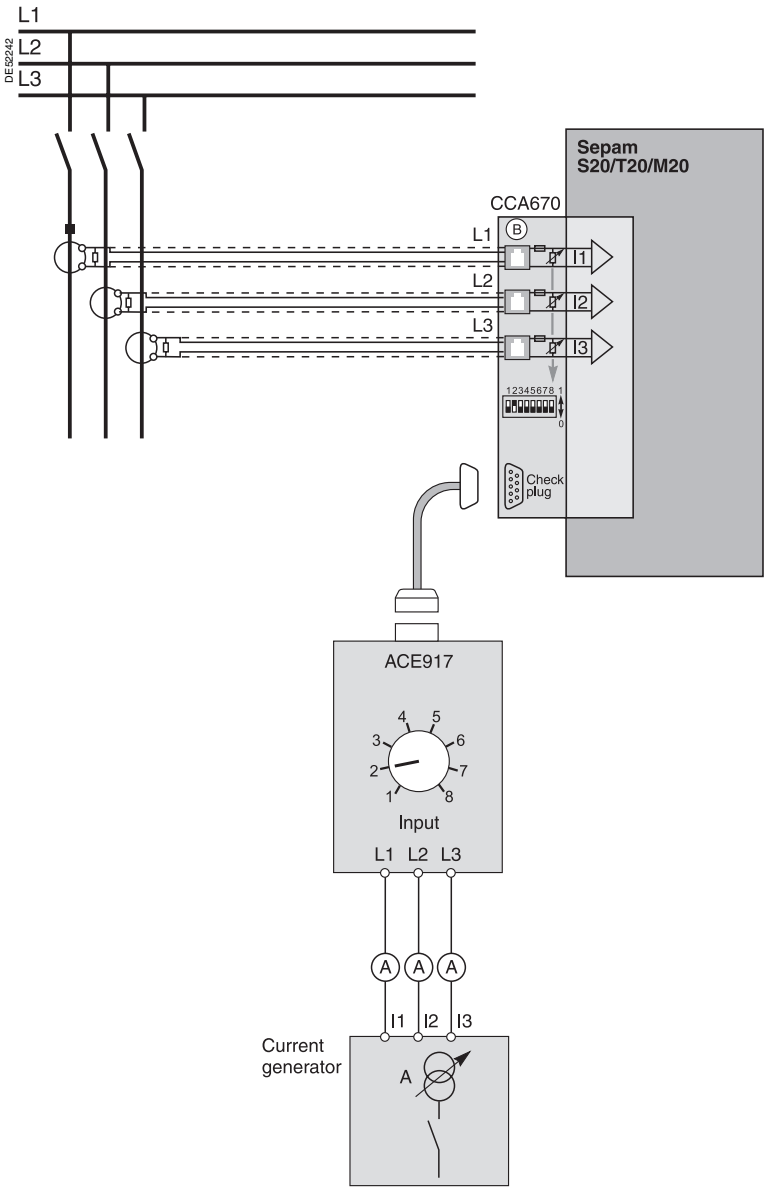
To test current inputs connected to LPCT sensors with a standard injection box, the ACE917 injection adapter is required.

The ACE917 adapter is inserted between:
- the standard injection box
- the LPCT test plug:
  - integrated in the Sepam CCA670 connector
  - or transferred by means of the CCA613 accessory.

The ACE917 injection adapter should be set according to the currents selected on the CCA670 connector: the ACE917 setting should be equal to the number of the microswitch that is set to 1 on the CCA670.

The injection value depends on the rated primary current selected on the CCA670 connector and entered in the Sepam general settings, i.e.:
- 1 A for the following values (in Amps): 25, 50, 100, 133, 200, 320, 400, 630
- 5 A for the following values (in Amps): 125, 250, 500, 666, 1000, 1600, 2000, 3150.

Block diagram (without CCA613 accessory)



Checking of residual current input connection

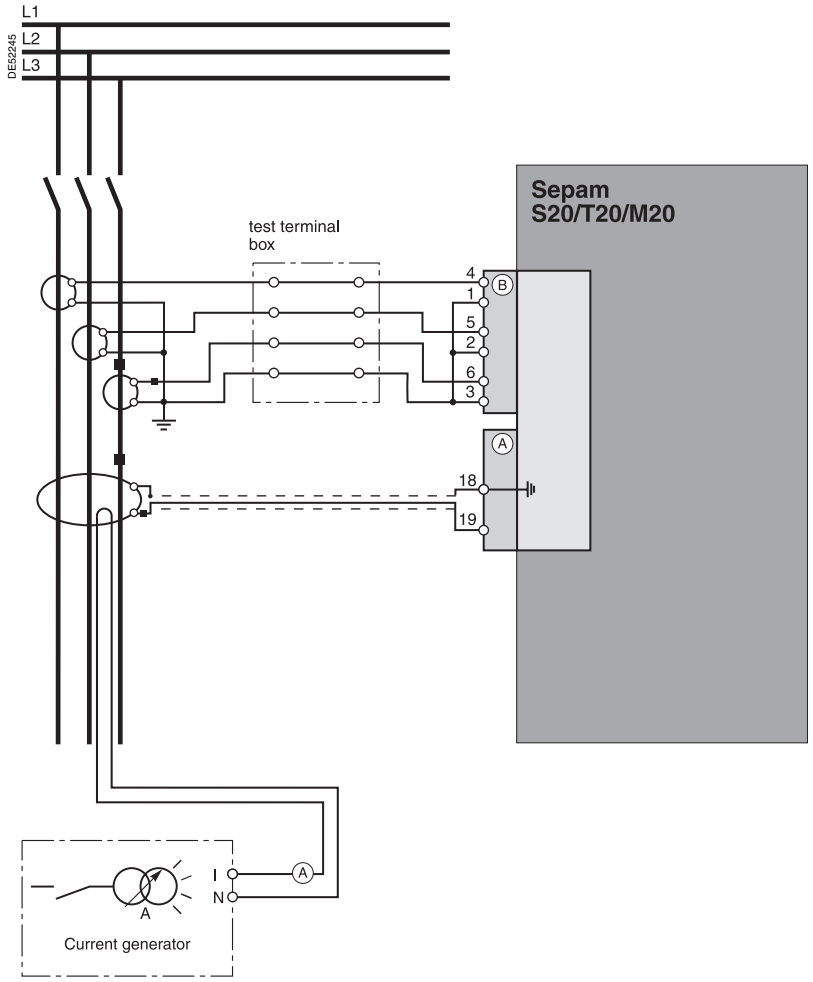
Description

Check to be carried out for Sepam S20, T20 or M20, when the residual current is measured by a specific sensor:

- CSH120 or CSH200 core balance CT
- another core balance CT connected to an ACE990 interface
- a single 1 A or 5 A CT encompassing the 3 phases, connected to a CSH30 interposing ring CT.

Procedure

- connect the single-phase current generator to inject current into the primary circuit of the core balance CT or the CT, in accordance with the diagram below:



- turn on the generator
- inject a 5 A primary residual current
- use the SFT2841 software to check that the residual current value is approximately equal to 5 A
- turn the generator off.

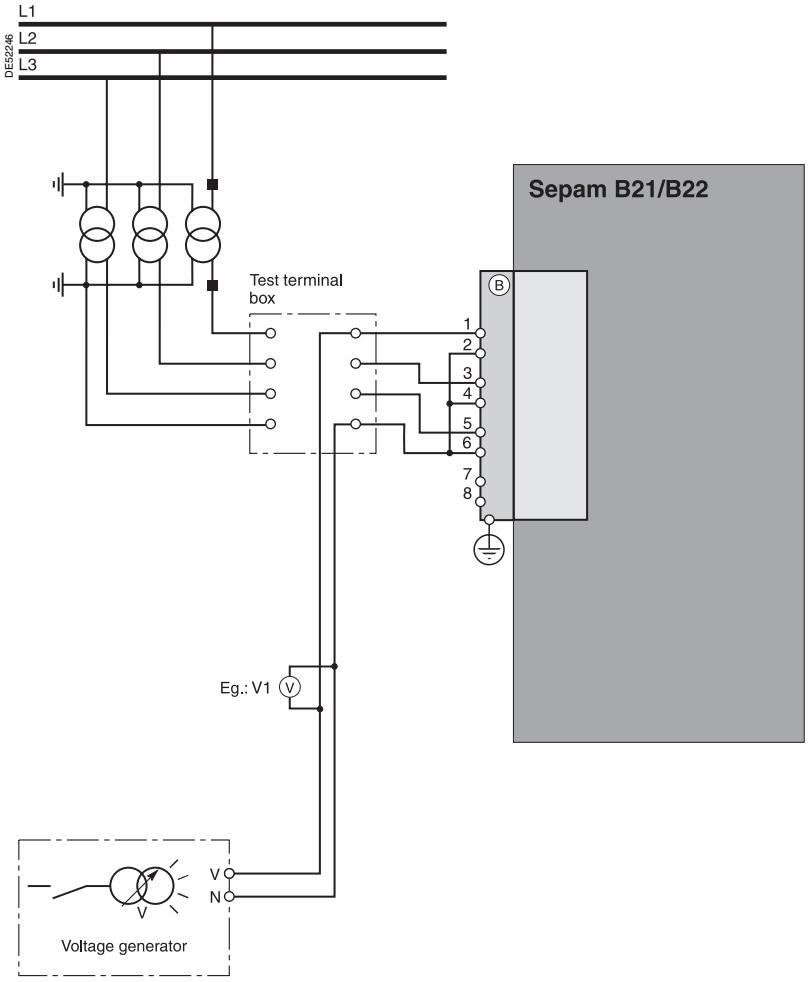
Checking phase voltage input connection

Description

Check to be carried out for Sepam B21 or B22.

Procedure

■ to apply a phase-to-neutral voltage to the phase 1 voltage input, connect the single-phase voltage generator to the test terminal box using the plug provided, in ccordance with the diagram below:



■ turn the generator on
■ apply the VT rated secondary phase-to-neutral voltage (Uns/$\sqrt{3}$)
■ use the SFT2841 software to check that the phase-to-neutral voltage V1 value is equal to the VT rated primary phase-to-neutral voltage (Unp/$\sqrt{3}$)
■ if the residual voltage is calculated by the sum of the 3 voltages, use the SFT2841 software to check that the residual voltage is approximately equal to the VT rated primary phase-to-neutral voltage (Unp/$\sqrt{3}$)
■ turn the generator off
■ proceed in the same way for the other 2 phase voltage inputs
■ at the end of the test, put the cover back on the test terminal box.

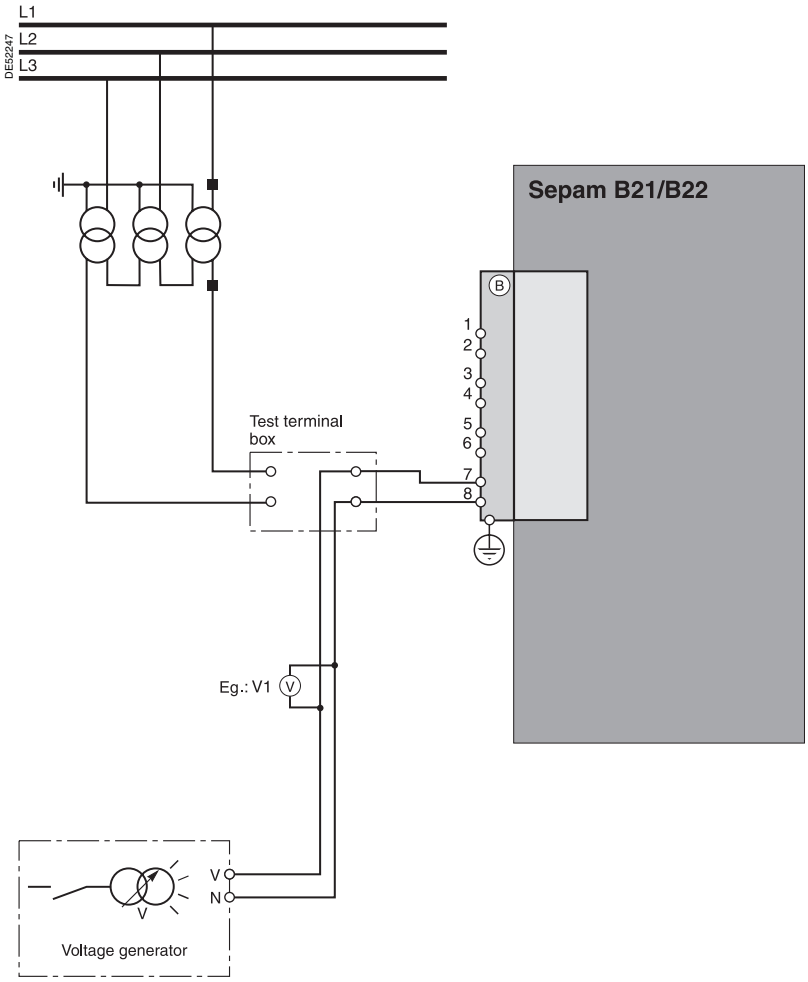
Checking of residual voltage input connection

Description

Check to be carried out for Sepam B21 or B22, when the residual voltage is measured by 3 VTs on the secondary circuits connected in an open delta arrangement.

Procedure

■ connect the single-phase voltage generator to the terminal test box using the plug provided, in accordance with the diagram below:



■ turn on the generator
■ apply the VT rated secondary phase-to-neutral voltage (Uns/$\sqrt{3}$)
■ use the SFT2841 software to check the residual voltag value Vo
■ Vo should be equal to the VT rated primary phase-to-neutral voltage (Unp/$\sqrt{3}$ or Vnp) if the VTs deliver Uns/$\sqrt{3}$ to the secondary circuit
■ Vo should be equal to the VT rated primary phase-to-phase voltage (Unp or $\sqrt{3}$ Vnp) if the VTs deliver Uns/3 to the secondary circuit
■ turn the generator off
■ put the cover back on the terminal test box.

Checking of logic input and output connection

MT10588

SFT2841 "Input, output, indicator status" screen.

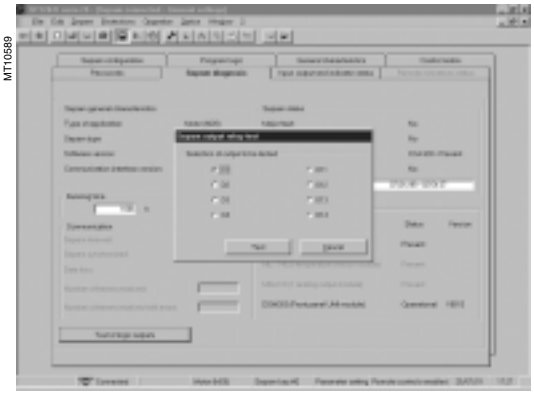
Checking of logic input connection

Procedure

Proceed as follows for each input:

- **if the input supply voltage is present,** use an electric cord to short-circuit the contact that delivers logic data to the input
- **if the input supply voltage is not present,** apply a voltage supplied by the DC voltage generator to the terminal of the contact linked to the chosen input, being sure to comply with the suitable polarity and level
- **observe the change of status of the input** using the SFT2841 software, in the "Input, output, indicator status" screen
- at the end of the test, if necessary, press the SFT2841 Reset key to clear all messages and deactivate all outputs.

MT10589



SFT2841 "Sepam Diagnosis - output relay test" screen.

Checking of logic output connection

Procedure

Check carried out using the "Output relay test" function, activated via the SFT2841 software, in the "Sepam Diagnosis" screen.

Only output O4, when used for the watchdog, can be tested.

This function requires prior entry of the "Parameter setting" password.

- activate each output relay using the buttons in the SFT2841 software
- the activated output relay changes status over a period of 5 seconds
- observe the change of status of the output relay through the operation of the related switchgear (if it is ready to operate and is powered), or connect a voltmeter to the terminals of the output contact (the voltage cancels itself out when the contact closes)
- at the end of the test, if necessary, press the SFT2841 Reset key to clear all messages and deactivate all outputs.

Validation of the complete protection chain

Principle

The complete protection chain is validated during the simulation of a fault that causes tripping of the breaking device by Sepam.

Procedure

- select one of the protection functions that triggers the breaking device
- according to the type of Sepam, inject a fault current or voltage
- observe the tripping of the breaking device.

Checking of optional module connection

Checking of temperature sensor inputs to the MET148-2 module

The temperature monitoring function provided by Sepam T20 or M20 units checks the connection of each sensor that is configured.
An "RTD FAULT" alarm is generated whenever one of the sensors is detected as being short-circuited or disconnected (absent).
To identify the faulty sensor or sensors:

- display the temperature values measured by Sepam T20 or M20 using the SFT2841 software
- check the consistency of the temperatures measured:
  - the temperature displayed is "****" if the sensor is short-circuited (T < -35 °C)
  - the temperature displayed is "-****" if the sensor is disconnected (T > 205 °C).

Checking of analog output connection to the MSA141 module

- identify the measurement associated by parameter setting to the analog output using the SFT2841 software
- simulate, if necessary, the measurement linked to the analog output by injection
- check the consistency between the value measured by Sepam and the indication given by the device connected to the analog output.

Test sheet
Sepam series 20

Project: **Type of Sepam**

Switchboard: **Serial number**

Cubicle: **Software version** V

Overall checks

Check of the box ☐ when the check has been made and been conclusive

Type of check	
Preliminary general examination, prior to energizing	☐
Energizing	☐
Parameter and protection settings	☐
Logic input connection	☐
Logic output connection	☐
Validation of the complete protection chain	☐
Analog output connection to the MSA141 module	☐
Temperature sensor input connection to the MET148-2 module (for type T20 or M20)	☐

Checking of Sepam S20, T20 or M20 current inputs

Type of check	Test performed	Result	Display	
Phase current input connection	Secondary injection of CT rated current, i.e. 1 A or 5 A	CT rated primary current	I1 = I2 = I3 =	☐
Residual current value obtained by 3 phase CTs	Secondary injection of CT rated current, i.e. 1 A or 5 A	CT rated primary current	I0 =	☐
Residual current input connection to a specific sensor: ■ **CSH120 or CSH200** ■ **other core balance CT + ACE990** ■ **1 x 1 A or 5 A CT + CSH30**	Injection of 5 A into primary circuit of core balance CT or CT	Injected current value	I0 =	☐

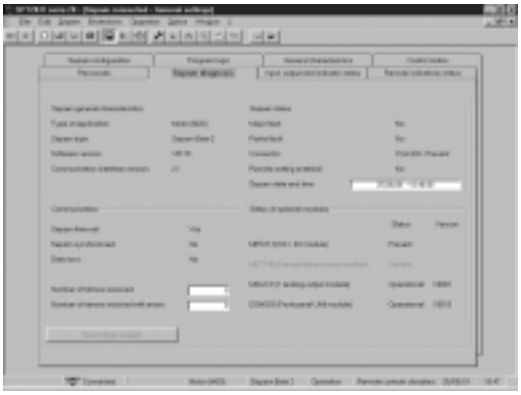
Checking of Sepam B21 or B22 voltage inputs

Type of check	Test performed	Result	Display	
Phase voltage input connection	Secondary injection of VT rated phase-to-neutral voltage Uns/$\sqrt{3}$	VT rated primary phase-to-neutral voltage Unp/$\sqrt{3}$	V1 = V2 = V3 =	☐
Residual voltage value obtained by 3 phase VTs	Secondary injection of VT rated phase-to-neutral voltage Uns/$\sqrt{3}$	VT rated primary phase-to-neutral voltage Unp/$\sqrt{3}$	V0 =	☐
Connection of residual voltage input	Secondary injection of voltage Uns/$\sqrt{3}$	Residual voltage = Unp/$\sqrt{3}$ (if Uns/3 VT) = Unp (if Uns/3 VT)	V0 =	☐

Tests performed on: **By:**	**Signatures**
Comments:	

Maintenance

Sepam has a large number of self-tests that are carried out in the base unit and additional modules. The purpose of the self-tests is:
■ to detect failures that may lead to nuisance tripping or the failure to trip when a fault occurs
■ to put Sepam in the fail-safe position to avoid user errors
■ to notify the operator that a maintenance operation is required.
The "Sepam diagnosis" screen of the SFT2841 software provides access to data on the status of the base unit and optional modules.

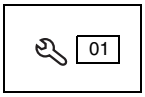

MT10587

SFT2841 "Sepam Diagnosis" screen.

Shutdown of the base unit in fail-safe position

The base unit goes into the fail-safe position in the following conditions:
■ detection of an internal failure by the self-tests
■ sensor interface connector missing (CCA630, CCA670 or CCA640 according to the type of application)
■ no connection of one of the 3 LPCT sensors to the CCA670 (connectors L1, L2 and L3)
■ MES module configured but missing.

The fail-safe position is conveyed by:
■ ON indicator on
■ indicator on the basis unit steadily on
■ relay O4 "watchdog" in fault position
■ output relays dropped out
■ all protection units inhibited
■ display showing fault message



■ indicator on DSM303 module (remote advanced UMI option) flashing.

Downgraded operation

The base unit is in working order (all the protection functions activated are operational) and indicates that one of the optional modules such as DSM303, MET148-2 or MSA141 is faulty or else that a module is configured but not connected.
According to the model, this operating mode is conveyed by:
■ Sepam with integrated advanced UMI (UD base):
□ ON indicator on
□ indicator on the base unit flashing, including when the display is out of order (off)
□ indicator on the MET or MSA module faulty, steadily on.
The display shows a partial fault message and indicates the type of fault by a code:
□ code 1: inter-module link fault
□ code 3: MET module unavailable
□ code 4: MSA module unavailable.
■ Sepam with remote advanced UMI, UX base + DSM303:
□ ON indicator on
□ indicator on the base unit flashing
□ indicator on the MET or MSA module faulty, steadily on
□ the display indicates the type of fault by a code (same as above).
Special case of faulty DSM303:
□ ON indicator on
□ indicator on base unit flashing
□ indicator on DSM steadily on
□ display off.
This Sepam operating mode is also transmitted via the communication link.

Temperature sensor fault

Each temperature monitoring function, when activated, detects whether the temperature sensor associated with the MET148-2 module is short-circuited or disconnected.
When this is the case, the alarm message "RTD FAULT" is generated.
Since this alarm is common to the 8 functions, the identification of the faulty sensor or sensors is obtained by looking up the measured values:
■ measurement displayed "****" if the sensor is short-circuited (T < -35 °C)
■ measurement displayed "-****" if the sensor is disconnected (or T > +205 °C).

Replacement and repair

When Sepam or a module is considered to be faulty, have it replaced by a new product or module, since the components cannot be repaired.

Notes

Notes

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Schneider Electric Industries SAS
89, boulevard Franklin Roosevelt
F - 92500 Rueil-Malmaison (France)
Tel : +33 (0)1 41 29 85 00

http://www.schneider-electric.com
http://www.sepamrelay.merlin-gerin.com

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